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THE AUTHORS OF THE SEVERAL PAPERS ARE SEVERALLY RESPONSIBLE FOR THE SOUNDNESS OF THE OPINIONS GIVEN AND FOR THE ACCURACY OF THE STATEMENTS MADE THEREIN.

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[PROC. ROY. SOC. VICTORIA, 22 (N.S.), PT. I., 1909.]

ART. I.—*On a New Species of Leperditia from the Silurian of Yass, New South Wales.*

BY FREDERICK CHAPMAN, A.L.S., F.R.M.S.,

National Museum, Melbourne.

(With Plates I., II.)

[Read 15th April, 1909.]

PRELIMINARY REMARKS.

The principal published descriptions of the Yass Silurian fauna are to be found in C. Jenkins' paper "On the Geology of the Yass Plains,"[1] and Prof. T. W. E. David's "Report on the Fossiliferous Beds, Yass."[2] The former author records "*Pterinea*" and "*Modiolopsis*" from the horizon whence our specimens were obtained, and it is probable that our *Leperditia* and Jenkins' *Modiolopsis* are one and the same. In the vertical section in Prof. David's Report, ostracoda are recorded from bed I., associated with *Pterinea laminosa* (=(?) *Rhombopteria*) and "*Spirifer yassensis*" (=*S. aff. plicatellus*, L. sp.). Beyond the above references, no other information concerning the Yass *Leperditiae* appears to have been recorded.

In November, 1903, Mr. A. J. Shearsby, F.R.M.S., of Yass, presented to the National Museum, among other fossils, a good series of *Leperditiae* on blocks of shaly micaceous mudstone from Cliftonwood, Yass, N. S. Wales. This genus of ostracoda has been recorded from Australia,[3] but no species have yet been described.

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1 Proc. Linn. Soc. N. S. Wales, vol. iii., 1878, pp. 21-32.

2 Ann. Rep. Dept. Mines, N. S. Wales (for 1882), 1883, p. 148; and especially sections (vertical and horizontal), with accompanying notes.

3 Prof. Ralph Tate, in his "Cambrian Fossils of S. Australia," Trans. Roy. Soc. S. Australia, vol. xv., 1892, p. 187, records two forms of *Leperditia* in the Cambrian Limestone of (?) Curramulka, one of which he says "has much resemblance to *L. dermatoides*, Walcott." These examples of Tate's have been kindly lent me by my friend Mr. W. Howchin, and in addition two other specimens from Mr. Sweet's collection will presently be described.

Leperditia shearsbii, sp. nov. (Plate I.).

Description.—Carapace elongate, sub-oval. Right valve larger, and with the ventral overlap well-marked. Seen from the side, dorsal line straight, ventral margin evenly curved; narrowly rounded in front and incurving at a sharp angle to the antero-dorsal angle; widely rounded behind and meeting the dorsal border with little or no angularity, differing in this respect from the allied *L. marginata*, Keyserling sp.[1] Central tubercle situated in the middle of a large, well-defined prominence, and somewhat anterior in position. In front of this tumid area the surface of the valve is strongly compressed, and this is extended, as a narrow marginal flange, more or less all round the carapace. Casts of this ostracod show the marginal compression more uniformly. This latter feature was noticed by Keyserling, especially in his (?) adult or large example, and was ascribed to the presence of an inverted ventral plate. Some of the casts in the present series also support the idea of an internal flange. Behind the central tubercle the surface of the valve slopes, at first rather rapidly, and then gradually, to within the area of the posterior third. The lucid or muscle spot is best seen on the interior of the valves, appearing as a circular depression marked by a network of fine polygonal grooves with a general radial arrangement. Anterior tubercle (eye-spot) small, round and always conspicuous; situated closer to the antero-dorsal angle than in *L. balthica*, His. sp., and more exactly in the position shown by *L. marginata*. The structure of the valves is clearly brought out in weathered examples, and the coarse pittings and radial grooving in proximity to the central tubercle is then well seen.

Measurements (in millimetres).

	Length	Height	Thickness
Spec. A.	3.75	2.25	—
Spec. B.	5	3	1 (rt. valve)
Spec. C.	7.5	4.75	—

1 "*Cypridina marginata*," Keyserling. Wissenschaftliche Beobachtungen auf einer Reise in das Petschora-Land (Geognostische Beobachtungen), 1846, p. 288, pl. xi., f. 16.

Affinities.—The well-known *L. balthica*, Hisinger sp.,[1] bears some points of resemblance to the above-described form, as in the structure of the carapace around the central tubercle; but the united valves are much thicker, the postero-dorsal angle is sharper, and the central tubercle is more median than in our species. Our fig. 2 is near *L. eichwaldi* of Schmidt,[2] in general outline, especially in his fig. 29. In *L. eichwaldi*, however, and the next to be noticed, there is a decided difference, in the sharp truncation of the postero-dorsal angle, already remarked upon, and which in our species is evenly rounded off. *L. eichwaldi* possesses a marginal flange, but not so well developed as in *L. marginata*, Keys. The figures of *L. marginata* given with Keyserling's original description show a great variation in size, but the essential characters are the same. Prof. T. Rupert Jones,[3] in reviewing this species, remarked that he suspected the smaller individual to be an adult form of a distinct species. The present extensive series shows just such a large amount of variation in size, which naturally leads us to conclude that Keyserling's species, like ours, was really subject to great dimensional variation. In the relative thickness of the carapace and the position of the central tubercle, the Australian and Petschora-Land specimens agree, leaving the fundamental and characteristic differences of the shape of the hinder end of the carapace as sufficiently striking to warrant a new designation for the Yass examples.

Other species of the *L. marginata* type which may be compared with *L. shearsbii* are *L. isochilinoides*, Jones,[4] from schistose sandstone of Devonian age, Spitzbergen, and *L. nordenskjoeldi*, Schmidt,[5] from Upper Silurian rocks in the Island of Waigatsch. The latter species, however, is not so narrow in front (side aspect), nor so roundly truncate at the dorsal angle of the hinder end.

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1 "*Cytherina balthica*," Hisinger. Lethæa Suecica, 1837, p. 10 and 118, pl. i., figs. 2, a, b; pl. xxx., fig. 1.

2 "Ueber die Russischen silurischen Leperditien." Mem. Acad. Imp. Sci. St. Petersb., ser. 7, vol. xxi., 1874, p. 17, pl.— figs. 19-21.

3 "Notes on the Palæozoic Bivalved Entomostraca, No. iii. Some species of *Leperditia*." Ann. Mag. Nat. Hist., ser. 2, vol. xvii., 1856, p. 94.

4 Ann. Mag. Nat. Hist., ser. 5, vol. xii., 1883, p. 247, pl. ix., figs. 1-9.

5 Mem. Acad. Imp. Sci. St. Petersb., ser. 7, vol. xxxi., No. 5, 1883, pl. i., figs. 29-32.

L. marginata, Keys., which may be regarded as the nearest related form to ours, has been recorded from Upper Silurian strata of the Swedish and Russian Baltic area. The form recorded by Prof. Jones from Silurian Limestones, Pine Island Lake, on the English or Great River, Canada, under the above name[1], was later re-determined as *Isochilina grandis*. A British example of *L. marginata* is known from the Downtonian Sandstone of Kington, Herefordshire[2].

Occurrence.—In flaggy micaceous sandstone of Upper Silurian age. Cliftonwood, Yass, N. S. Wales.

Notes on the Leperditia Bed and Associated Strata.

The following note on the bed has been kindly supplied by Mr. Shearsby.—"*Leperditiae*. These are found in large numbers in a thin layer of micaceous mudstones shown in the photograph (Pl. II.) by a thin white line. Myriads of these occur in a layer which is not more than an inch thick. Only a few are to be found just above or below this zone; perhaps the matrix—sandstone—was unsuitable for their preservation. In this thin layer, also, are to be found enormous numbers of a bivalve shell, probably referable to *Rhombopteria*."

Mr. Shearsby has kindly forwarded an interesting collection of fossils associated with the *Leperditiae*, and has supplemented these with notes of other genera and species as given below.[3]

The *Leperditia* Bed.—The bivalve shell referred to by Mr. Shearsby is closely allied to *Rhombopteria*, and may prove to be identical with De Koninck's *Pteria laminosa*, which that author recorded[4] from "argillaceous limestone, Yass District." In the same bed there is a *Loxonema* (casts), and some crushed shells of a *Spirifer* allied to *S. plicatellus*, L. sp.

Below the *Leperditia* Bed.—*Spirifer* cf. *plicatellus* (narrow var.); *Favosites* sp., a branching form (Mr. Shearsby has traced one example for over a foot in length, giving off many branches). This latter occurs 12 inches below the *Spirifer* bed. Near the

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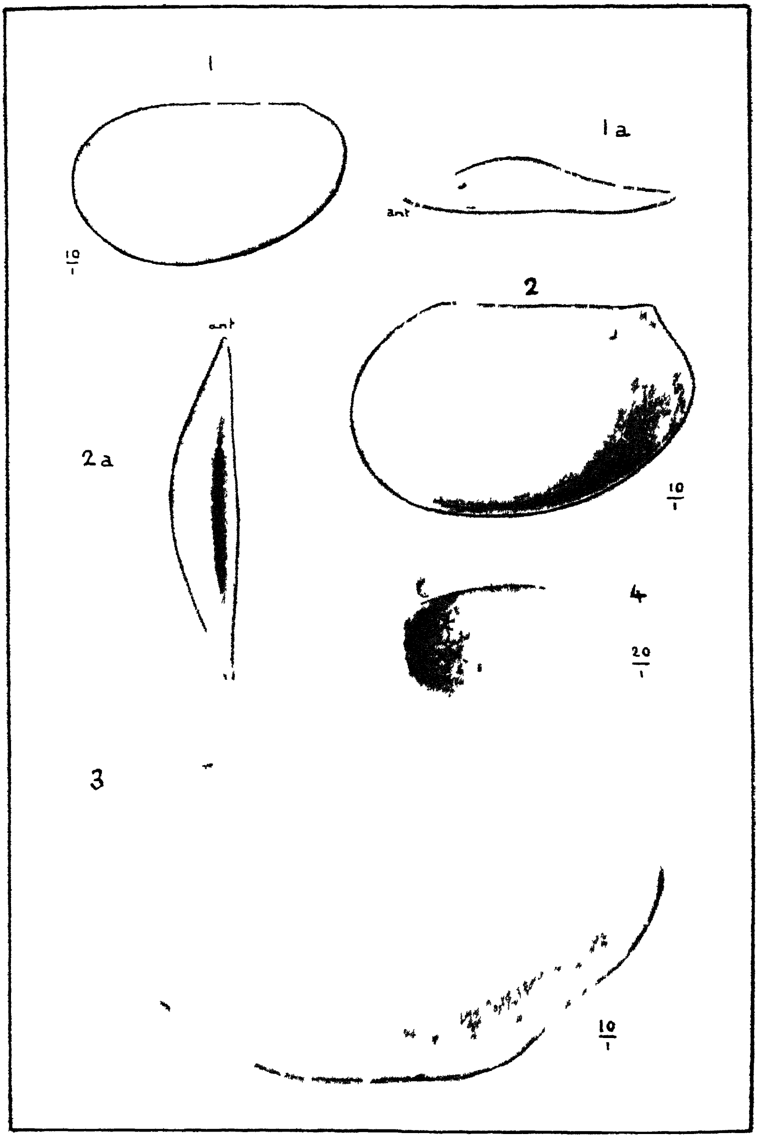
1 Ann. Mag. Nat. Hist., ser. 2, vol. xvii., 1856, p. 94, pl. vii., fig. 14.

2 Loc. supra cit., p. 95, pl. vii., fig. 15.

3 Details of the separate horizons and their fossil faunas will be shortly given in a paper by Mr. Shearsby.

4 Mem. Geol. Surv. N. S. Wales, Palæont., No. 6, 1898, p. 92, pl. iii., fig. 12.



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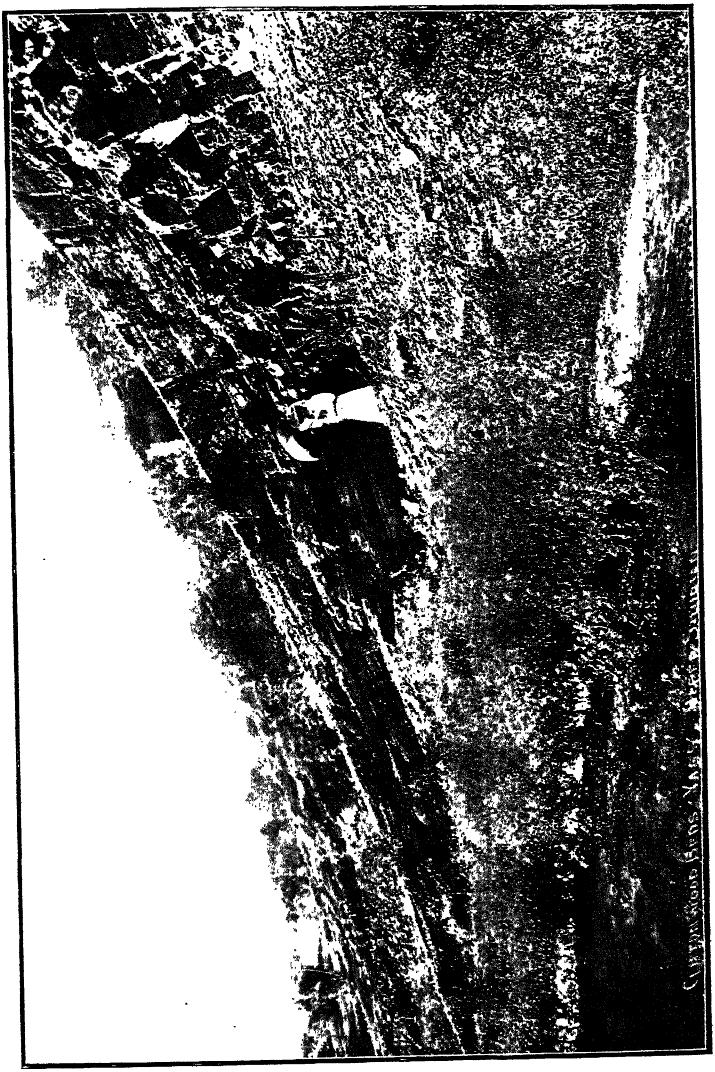
Leperditia shearsbii, sp nov, Up. Silurian, Yass.



A. J. Shearsby, Photo.

Section of Upper Silurian Beds, Cliftonwood, Yass, N.S.W.

Leperditia zone shown by white line.

base of this laminated and calcareous mudstone series, (?) crustacean tracks were noticed; also a *Lingula* and some bivalve remains.

Above the *Leperditia* Bed.—10 feet of calcareous mudstone with no fossils. Then 3 feet of comparatively fossiliferous limestone with *Heliolites* sp. and *Spirifer plicatellus*. Above this again, 18 inches of unfossiliferous micaceous sandstone. Then 3 feet of calcareous mudstone, highly fossiliferous, containing cf. *Cystiphyllum* sp., *Rhizophyllum interpunctatum*, De Kon.; *R. robustum*, Shearsby; *Tryplasma* sp.; *Favosites* sp.; *Heliolites* cf. *interstincta*, L. sp.; *Orthothetes shearsbii*, Dun; *Spirifer* aff. *plicatellus*, L. sp.; *Murchisonia* sp.; and *Encrinurus* cf. *punctatus*, Brunn. sp. Laid down upon this are 150 feet of shales and mudstones capped by a few feet of impure limestone containing an enormous number of fossils, some of which are:—*Cyathophyllum* sp.; *Heliolites* sp.; Crinoid remains; *Lingula* aff. *lewisi*, Sow.; *Orthothetes shearsbii*; *Atrypa reticularis*, L. sp.; cf. *Meristina australis*, Dun; *Spirifer* aff. *S. fimbriatus*, Conrad; (cf.) *Paracyclas* sp.; (cf.) *Megambonia* sp.; *Bellerophon* sp.; (?) *Endoceras* sp. Over this there are about 150 ft. of grits, sandstones and calcareous shale, which is finally cut off by porphyry.

EXPLANATION OF PLATES.

Plate I.

Fig. 1.—*Leperditia shearsbii*, sp. nov. A right valve of a small individual. 1a, dorsal edge view. × 10.

Fig. 2.—*L. shearsbii*, sp. nov. Type. Carapace from the right side of a normal-sized individual. 2a, ventral edge view. × 10.

Fig. 3.—*L. shearsbii*, sp. nov. Cast of a large individual, showing the deep marginal depression. × 10.

Fig. 4.—*L. shearsbii*, sp. nov. Portion of interior of a valve, showing "eye-spot" with vascular markings. × 20.

Plate II.

Photograph of section of the Upper Silurian strata at Cliftonwood, Yass. (The white line marks the *Leperditia* bed).

[PROC. ROY. SOC. VICTORIA, 22 (N.S.), PT. I., 1909.]

ART. II.—*Contributions to the Flora of Australia, No. 11.*[1]

BY

ALFRED J. EWART, D.Sc., PH.D., F.L.S.

(Government Botanist),

JEAN WHITE, D.Sc.; AND BERTHA REES

(Victorian Government Research Bursars);

WITH APPENDICES BY

J. R. TOVEY AND J. W. AUDAS,

Of the National Herbarium.

(With Plates III.-X.)

[Read 13th May, 1909.]

ACACIA MACKEYANA, n. sp., Ewart and White (Leguminosae). In recognition of the services of the Hon. J. E. Mackey towards the establishment of the National Park at Wilson's Promontory.

Cowcowing, W. Australia, M. Koch. No. 1013.

Branches minutely pubescent. Phyllodia shortly petiolate, about 1 cm. in length, pungent, pointed, terete, with from 16 to 20 longitudinal striae, pale green, rigid, 1-2 mm. in diameter, fairly numerous, alternate, glabrous; stipules, if present, deciduous. Flowers grouped into small heads with about 12 to 20 on each head, the peduncles average 5 mm. in length, the heads usually solitary. Five sepals, free except at the extreme base, each sepal has a distinct stalk and lamina, both provided with simple transparent hairs, yellow. There are generally 2 larger and 3 smaller sepals to each flower, nearly as long as the petals. Corolla of 5 petals, which are membranous and

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1 No. 10 in Proc. Roy. Soc. Victoria, vol. xxi., 1909, p. 540.

deep yellow in colour, with a fairly prominent midrib, united for about three-quarters of their length. Stamens very numerous, free except at the extreme base, anthers two-celled.

Legume usually curved sharply at the base so as to form various shapes, about 1 to 2 cm. long in these specimens, stalked, dark brown and rather rigid, slightly compressed and sparsely provided with hairs, which are more abundant at the tip. Fully ripe fruit not seen.

The plant bears some resemblance to a specimen of "A. aciphylla" (Planta Preissiana, 976) placed under A. campylophylla, but the specimen is sterile and the phyllodes are considerably longer. It comes from Steetz's Herbarium, and was marked near to *A. colletioides* and *A. striatula.*

ACACIA SERICOCARPA, W. V. F. = ACACIA MERRALLII, F. v. M. (Leguminosae).

Beyond a greater tendency to hairiness in the young stem and fruits no valid specific distinction can be seen, as regards flower, leaf, stem, or fruit between Fitzgerald's specimens and those of *A. Merrallii,* F. v. M. Fitzgerald admits that "carpologically the two species are very close," but considers that *A. Merrallii* differs in being "almost or quite glabrous, the margins of the phyllodia much thickened, and the venation hardly discernible." These are, however, all variable features, and specimens considered to be *A. Merrallii*, when submited to Fitzgerald, were marked *A. sericocarpa,* W. v. F. This is in fact merely a form of *A. Merrallii,* F. v. M., in which the young fruits are conspicuously hairy.

ALLENIA,[1] Ewart (Euphorbiacae). After Prof. H. B. Allen.

Flowers monoecious. Male flower—solitary, or two together in axils of leaves. Perianth, 4 segments in two whorls, concave, petal-like, red; outer with broad base and narrow tip, inner with narrower base and broader tip, imbricate in bud. Stamens 4, anther lobes separate and reniform in shape, dehiscing longi-

1 Apart from the different second vowels, Allania Benth. is now Aldinia Endl., and Allania Meissn. is now Alania Endl.

tudinally by two valves. Stamens opposite segments of perianth, filaments apparently curved in bud, and attached to central disc. Disc small and quadrilateral, 4-partite.

Female flower—solitary and axillary. Perianth persistent, 4 segments in two whorls. Each segment with wide base and narrow, pointed tip; two outer smaller and somewhat reflexed. Ovary—2 carpels and 2 tongue-like stigmas, thick, fleshy, diverging.

Fruit oblong, 2-celled capsule with persistent perianth. One seed in each cell, oblong, smooth, with caruncle. Embryo green, straight, linear, cotyledons slightly longer and about same width as radicle.

ALLENIA BLACKIANA, Ewart and Rees.
(MICRANTHEUM DEMISSUM, F. v. M.).

Small heath-like shrubs. Leaves on very short petioles, small, entire linear, coriaceous, in alternate twos or threes, hairy to glabrous; with prominent midrib and slightly thickened margin. Stem woody, with short, stiff hairs.

Mt. Victor, 1881, Tepper; St. Vincent Gulf, 1882, Tepper.

Mount Compass, Kangaroo Island, Nov., 1908, J. M. Black.

The type form has the leaves glabrous or slightly hairy, linear, alternate, ¼ to ½ inch long. Capsule oblong, rather elongated, glabrous.

Var. MICROPHYLLA, n. var.

Small, rigid, much branched shrub. Leaves very small, ⅛ inch long, hairy, capsule oblong, rather shorter, and covered with hairs.

E. H. H. Griffith, Snug Cove, Kangaroo Island.

Specimens of the plant were forwarded by J. M. Black, who pointed out that if they were Mueller's *Micrantheum demissum* the numbers of parts in the flower and fruit differed from that proper to the genus *Micrantheum*. This was found to apply to all the specimens, and hence it became necessary to raise a new genus *Allenia*, distinguished from *Micrantheum* and *Pseudanthus*, by the perianth four-partite instead of six-partite, by the four instead or 3, 6 or more stamens, and by the 2-celled

ovary forming a 2-celled capsule with one seed in each cell. The leaves are like those of Micrantheum, but are in twos as well as in threes. In the absence of good material the general resemblance to *M. ericoides* naturally led Mueller to place it in that genus. As can be seen from the original description quoted beneath, Mueller's material was too imperfect for him to distinguish the peculiarities of the male and female flowers, and of the fruit.

MICRANTHEUM DEMISSUM, F. v. M. In Vict. Nat., vol. vii., p. 67, 1890.

Dwarf; branchlets beset with short spreading hairlets; leaves ovate or lanceolar-elliptic, generally soon almost glabrous, at the margin hardly or narrowly recurved; pistillate flowers axillary, solitary; sepals longer than the pedicels, almost elliptic; fruit hardly thrice longer than the sepals, nearly ovate, at the base blunt, towards the summit more attenuated; seeds brownish, shining; strophiola pale, turgid, nearly semi-ovate, about thrice shorter than the seed.

Closely allied to M. ericoides, but still more dwarfed, the leaves mostly broader, the pedicels usually shorter, the sepals somewhat larger, the styles less elongated and the fruit smaller; perhaps the staminate flowers will also prove different.

M. hexandra, to which the South Australian species was in the first instance referred, chiefly on geographic considerations, is a tall highland-plant, larger in all its parts, thus already quite distinct, it produces stamens up to nine in number.

ARGOPHYLLUM NULLUMENSE, R. T. Baker. Proc. Linn. Soc. N. S. Wales, xxii., 1897, p. 232; xxiv., 1899, p. 439 = A. NITIDUM, Forst. (Saxifrageae).

It is not possible to distinguish this plant from *A. nitidum* by any well-defined, constant characters. Distinctions derived from the shape and appearance of the leaves are rarely wholly reliable. The first Australian specimens appear to have been identified by Baron von Mueller, and the plant was recorded under this name in Bailey's Queensland Flora.

Three varieties are recognisable under this species.

(1) Variety *fulva*, with rusty-coloured leaves. This has been raised to specific rank as *A. cryptophlebum* by Dr. Marg. Zemann. (Herb. Musei Palat, Vindob.).

(2) Variety cryptophleba is wrongly given in Bailey's Flora of Queensland under *A. Lejourdanii.* The leaves are larger, whiter, and do not possess the numerous short, sharp teeth mentioned by Bailey. Various localities in Queensland.

(3) Variety *nullumense.* (A. nullumense, R. T. Baker.) This is intermediate, having more the leaf shape and smaller leaves of variety fulva, but the silvery under-surface of var. cryptophleba.

Atriplex lobativalve, F. v. M. Icon. Austr. Salsol., pl. 6; and Vict. Nat., ix., 1893, p. 187.

This species is wrongly given as *A. lativalve* in the Kew Index, 1st Suppl., 1886-1895.

Caleya Sullivani, F. v. M. (Orchidaceae).

Recorded by C. French for Gisborne in the Vict. Nat., vol. 22, 1906, p. 163.

The plant proves to be a form of *Caleana minor*, R. Br. Only a single authentic specimen of *C. Sullivani* is known, and this is from the Grampians. It may prove to be merely a somewhat aberrant form of *C. minor*.

Calochilus paludosus, R. Br. (Orchidaceae).

Recorded by Mr. F. M. Reader as new to Victoria in Vict. Nat., 1909, vol. xxv., p. 171.

The specimen proves to be *C. Robertsoni*, Benth., a Victorian species. It has the shortly-rostrate anther of that species, and tallies exactly with specimens identified by Mueller and by Bentham, and also with an earlier specimen of Mr. Reader's. Mueller proposed at one time (Fragm., v. 96) to unite the 3 Australian species, but subsequently abandoned this view. Though close, the species seem to be distinguished by valid constant characters.

CENTROLEPIS PLATYCHLAMYS, F. M. Reader = C. GLABRA, Hier. (Centrolepideae).

This genus is a difficult one, and the boundary of the species somewhat hard to define, but there seems to be no sound reason for maintaining this species as distinct from *C. glabra*, as can be seen from the following comparison:—

C. GLABRA, Hier.	C. PLATYCHLAMYS, F. M. Reader.
Benth. Fl., vii., p. 204.	Vict. Nat., 1906, p. 23.
A small glabrous plant, with the habit of C. muscoides, but more slender.	A minute, slender, glabrous moss-like plant, usually under 1 inch.
Leaves capillary; scapes very slender, sometimes slightly exceeding the leaves, but more frequently shorter.	Leaves subulate filiform; in the larger plants shorter; in the smaller as long as, or slightly longer than, the scape.
Floral bracts close together, narrow, erect, the outer one about one line long, besides the point or awn at least half as long; the inner one narrower, without any point.	Floral bracts close together, erect or spreading, with the awn scarcely more than one line long; inner bract shorter, margin broadly membranous, no awn, and obtuse.
Flowers four, of which two usually without any stamen, and no hyaline scales.	Flowers, 3-5, two with a stamen and no scales; the others devoid of either.
Carpels of the ovary about 8, rarely 10.	Carpels of the ovary usually 5-9.

The membranous bases to the leaves, and the membranous edges of the bracts, are also shown by type specimens of *C. glabra*, and slight variations in the shape and size of the bracts and awns hardly justify the distinction of a new species. The features used to distinguish the "species" from *C. muscoides*, *C. pulvinata* and *C. pusilla* are precisely those which distinguish *C. glabra* from the same species. *C. glabra* is only recorded from a few localities in Victoria, viz.: Mt. Emu Creek, F. Mueller (1853); Richardson River, Miss Beal; Shire of Dimboola, Reader (1898); Lowan, Reader (1900); Hawkesdale, H. B. Williamson (1904 and 1908). It is also recorded from a few localities in West Australia, South Australia and Tasmania.

DAVISIEA GRAHAMI, Ewart and White, n. sp. (Leguminosae).

(After the Hon. G. Graham, Minister for Agriculture).

A small shrub with quadrangular or rigid, slightly-scabrous stems. Leaves sessile, with a horizontal articulation, but the laminas vertical and flat or somewhat curved; reaching 6 cms. in length and 1 to 1½ cms. in breadth at the base of the stem, but smaller and narrower towards the top; pungent, the tips tending to become hooked; lanceolate and narrowed at the base, somewhat coriaceous and distinctly veined.

Bracts small, but larger than in D. daphnoides; inflorescence axillary in small clusters of usually 3 or more flowers, each on a stalk of 2-4 mm. Calyx 3-4 mm., not turbinate, the teeth nearly half as long as the tube, tapering to blunt points and all of equal length. Petals purplish-brown and yellow, standard almost reniform, yellow with dark streaks, longer than the alae or carina, more than half the length of the calyx. Fruit apparently attaining ½ cm. or more on a stalk of 1 mm.

Jibberding and Watheroo Rabbit Fence, West Australia, M. Koch, 1905, No. 1365.

Specimens of the plant in Herb., N.S. Wales, were determined by W. V. Fitzgerald as *D. daphnoides*, Meissn. It differs from that species in the leaves, calyx and inflorescence. In spite of the dissimilar facies, its nearest affinities seem to be *D. acicularis* and *D. ulicina.* Some varieties of the latter develop fairly large and broad leaves.

DROSERA HUEGELII, Endl. var. FLAVIFLORA, n. var., W. V. Fitzgerald = D. MENZIESII, R. Br., var. FLAVESCENS, Benth. (D. intricata, Planch.).

Cowcowing, W.A., Max Koch, Dec., 1904, No. 1039. New locality for latter is L. Bonney, S. Australia, Mrs. Wehl, 1874.

EUCALYPTUS CORRUGATA, Luehmann.

In Vict. Nat., vol. xiii., p. 168, 1897.

This species is given by Diels, in Engler's Bot. Jahrb., vol. xxxv., p. 443, 1905, as a Herbarium name and queried as *E.*

goniantha, Turcz. In the Kew Index, 3rd Suppl. (1908), the name is queried similarly. The plant is fully described in the Victorian Naturalist, and its nearest affinities are to *E. incrassata* and *E. pachyphylla*. In the 2nd supplement of the Kew Index (1904) the name is given as valid, with the proper reference.

FREYCINETIA GAUDICHAUDII, Bennett. (Pandanaceae).

This is given by Warburg in Engler's Pflanzenreich as from Java only, and Bailey's record of the plant from Queensland dismissed as probably incorrect. Queensland specimens of this plant exist, however, in the National Herbarium which were examined both by Bentham and by Mueller, and referred to this species. Warburg also omits *F. insignis* from the Queensland Flora without any reason being given. It is given from Queensland on Baron von Mueller's authority and is included in the Census and in Bailey's Flora.

GILRUTHIA, Ewart, n. gen. (Compositae, Inulae-Gnaphalinae).

Simple heads of homogamous tubular florets without any subtending scales on the convex receptacle. Involucre of 5 or 6 rows of appressed scarious bracts, with a green midrib and short yellowish appressed tips, more conspicuous in the inner bracts. Pappus of a basal membranous ring with ascending teeth tapering into a small number of plumose filaments, of the length of the corolla. Corolla 5-toothed, golden-yellow anthers slightly tailed. Styles 2, almost terete, not thickened below the middle, truncate at the top.

Achene glabrous or faintly papillose, angular, not beaked, slightly flattened.

The heads are either single or in close, nearly sessile clusters of 3 or more, but quite distinct, and with a well-developed involucre. The pappus resembles that of some species of Calocephalus, while the style approaches that of some species of Angianthus or Helipterum. The genus forms an interesting connecting link between the Inulae-Angianthinae and the Inulae-

Guaphalinae (Angianthus-Calocephalus-Helichrysum). Its simple homogamous heads, bracts in several rows, with yellowish tips, truncate styles, etc., place it in the Guaphalinae, near to Helichrysum, between it and Helipterum, and indicate that the simple head of the latter is derived from the compound head of Angianthinae by the reduction of the partial heads to one flower and the suppression of the subtending scales. Indeed, a few scales are sometimes present between the central florets of Helichrysum.

GILRUTHIA OSBORNI, Ewart and White, n. sp. (after Professors Osborne and Gilruth).

A herb of 1 to 2 inches, branching at the base, stems woody, and, as well as the leaves, covered with soft white hairs. Leaves lanceolar, about ½ cm. long, woolly on both sides, narrowed at the base, but no distinct petiole, obtuse or somewhat pointed, flat or slightly revolute. Heads on short pedicels terminal, solitary or more usually in close clusters of three or more at the ends of the branches. Innermost bracts twice the length of the outermost series, which exceed a millimetre in length, and have only few hairs. The inner bracts with a double tuft of woolly hairs on the bract, below the tip.

Mt. Malcolm (north of Kalgoorlie), West Australia, F. Rodway, 123, Nov., 1906.

This puzzling little plant was placed by Hemsley, at Kew, as near to *Calocephalus Sonderi*, probably on account of the pappus, but the simple heads necessitate its inclusion in the Guapholinae, and the other peculiarities raise it to the rank of a new genus.

GREVILLEA BERRYANA, Ewart and White, n. sp. (Proteaceae. Group Cycloptera). After Professor Berry.

Shrub up to 20 ft. high. Stems woody and slightly glaucous, pubescent when young. Leaves alternate, petiolate, exstipulate, 6 to 9 inches long, compound, with 4 to 7 alternately arranged segments, the lowest segments 6 to 7 inches, the upper shorter,

and all coriaceous, rigid, linear, with entire margins. Each segment has 3 faint longitudinal grooves on the upper surface. and 2 conspicuous grooves on the under surface, which latter are somewhat sparsely pubescent; the midrib prominent on the under surface. The inflorescence is a raceme, the axis of which is $1\frac{1}{2}$ - 3 inches long, generally there are several racemes arranged in a panicle. Axis and peduncles are hairy, the latter being about one-twelfth inch in length. Flowers small, perianth about $\frac{1}{4}$ inch, the tube being slightly hairy outside, and the limb densely hairy outside, pale yellow in colour and glabrous inside. Limb globular, the segments concave, the tube curved under the limb, the segments cohering for a long time after the tube has opened. Anthers sessile in the concave lobes of the limb, all 4 perfect and 2-celled, almost globular. Style nearly $\frac{1}{2}$ inch long, curved, the stigma enclosed in the limb of the perianth and laterally situated. Ovary on a long stalk, glabrous. Torus small, straight, gland fairly conspicuous, horse-shoe shaped. Fruit large, almost spherical, compressed, $\frac{1}{4}$ to $\frac{1}{3}$ inch in diameter, hard and fairly thick-walled, glabrous. Seed single, cordate, with a very distinct wing all round.

F. A. Rodway, Malcolm, W. Australia, Dec., 1907, No. 321.

It differs from G. leucadendron in having a hairy inflorescence and perianth, and a laterally placed stigma. Pritzel considered it might agree with *G. nematophylla*, of which he had found compound leaved specimens, but the stigma is oblique instead of a cone, and the leaves, pedicels, inflorescences and flowers all differ from those of G. stenobotrya, F. v. M., and of G. Purdieana, Diels.

HELIPTERUM TROEDELII, F. v. M. (Compositae).

In the type form of this species the heads are aggregated in dense cymose clusters at the ends of the branches. A variety with the inflorescence more diffuse, and one or two heads at the end of branch is equally common, and may be termed variety *patens*, n. var.

Mt. Lyndhurst, M. Koch, No. 1644, 1899; Fraser Range, W. Austr., R. Helms, 1891.

HAKEA DACTYLOIDES, Cavanilles. (Proteaceae).

Collected a few yards west of the entrance to Mallacoota Inlet by C. C. Lacaita, 1909, and new for Victoria. This is another instance of a N. S. Wales, species extending down the coast line into Victoria.

KOCHIA ATKINSIANA, W. F. Fitzgerald. (Chenopodiaceae).

Near Champion Bay, West Australia, 1888. New locality.

This specimen was marked by Baron von Mueller, "lobes of calyx very large. With *Kochia villosa*." The erect lobes are flatter and broader than the type, but the other differences are trivial.

KOCHIA MURRAYANA, n. sp. Ewart and Rees. (Chenopodiaceae).
In recognition of the addition by the present Victorian Government of £1000 to the Annual Research Endowment Fund.

Isaac Tyson, 1908, Mt. Narryer, Murchison River, W.A.

Apparently a small shrub, stems and leaves covered with woolly hairs. Leaves alternate, sessile, linear, obtuse, flattened, half to one inch long, densely covered with woolly hairs. Flowers, solitary, axillary. Styles 2, persistent. Fruiting perianth convex and extending over fruit, surrounded by horizontal, membranous, finely-veined wings connected in a ring about half an inch in width. Total diameter, including fruit, about 1½ inches. Perianth woolly tomentose, the latter character extending partly over surface of wings. Calyx-tube woody. Pericarp thin and membranous.

The species is easily distinguished from K. villosa by the convex fruiting perianth, as well as by the large expansion of the wings and by the larger leaves.

MINURIELLA, Tate. Trans. Roy. Soc. S. Austr., xxiii., 1899, p. 288 = MINURIA, D. C. Benth. Fl., iii., p. 497. (Compositae).

Only one species was included under *Minuriella, M. annua*, Tate, which in the connate pappus of the disc florets shows an approach to *Minuria suaedifolia*. Minuriella is separated mainly

on account of the herbaceous habit of its only species, by its lateral, not terminal, flower heads, and by the longer corolla tube of the ray florets. The second feature is an error, the flower heads are as much terminal as in any species of *Minuria.* Tate's plant differs widely in external habit from any other species of *Minuria*, but not more than the species of this pleomorphic genus do among themselves. As Tate gives both generic names, the authority for the species need not be altered.

MONOTAXIS GRANDIFLORA, Endl. (Euphorbiaceae).

Unrecorded localities from recently determined specimens are : Max Koch, Wooroloo, W.A., Sept., 1907, No. 1759 ; sources of the Swan R., W.A., Alice Eaton, 1889, Mrs. Heal, 1893, F. Mueller, Nov., 1877, Serpentine R., F. Mueller, Dec., 1877.

Var. MINOR, new var., Ewart.

Occurs in short, compact clusters of 4 to 9 cms. height and breadth from one tap root, the leaves shorter and more closely set.

R. Helms, Nr. Warangering, W.A., Nov., 1891; and near Gnarlbine, W.A., Nov., 1891.

PANDANUS FORSTERI, Moore et F. v. M. (Pandaneae). Det. by U. Martelli.

Bald Hill Water-hole, Atherton Station, Queensland, J. Dallachy, 9th May, 1863; previously recorded from Lord Howe's Island.

PANDANUS SPIRALIS, R. Br.

Bentham made this species a synonym to *P. odoratissimus*, L. fil. Prof. U. Martelli proposes to restore it. On one specimen from Escape Cliff, Baron von Mueller had marked, "P. odoratissimus L. var.; P. spiralis, R. Br. Fruit always large, therefore perhaps R. Brown species to be restored." The species

come from N. Australia, but one specimen is marked Geographe Bay. This is in W. Australia, below latitude 33 deg., which is very far South for a tropical plant. Many tropical Queensland plants run down the coast into N. S. Wales, however, and N.S. Wales plants are found far down the east coast of Victoria. The moister conditions along the coast render temperature less inoperative as a limiting factor on distribution, and the proximity to the sea lessens the extremes of temperature. It is possible that tropical plants may also travel down the W. coast of Australia and reach sheltered localities, where they survive, as apparently in this case.

Warburg, in Enger's Pflanzenreich, 1900, p 46, makes both P. odoratissimus and P. spiralis synonymous to P. tectorius, Sol., (Prim. fl. in ins. pacif. inedit, 350. Parkinson's Journal of a Voyage to the S. Seas in H.M.S. Endeavour, 1773), L. odoratissimum dates from 1781. This is another instance of changing an established name for trivial priority reasons.

POLYGONUM PLATYCLADUM, F. v. M. Trans. Phil. Soc. Vict., 1858, vol. ii., p. 73 = MUEHLENBECKIA PLATYCLADA, Meissn. Bot. Ztg., 1865, vol. xxii., p. 313. (Polygonaceae).

The two species are kept apart in the Kew Index, and the locality for the latter given as Salomon Islands, and for the former New Caledonia. The plant is occasionally grown in gardens in Australia on account of its curious habit (flattened branches, deciduous leaves, and lateral clusters of small flowers and fleshy fruits). It is evidently a native both of the Salomon Islands and of New Caledonia. The fleshy perianth, darkening from red to almost black, is quite different to that of *Polygonum*. In the figure in Engler's Pflanzenfamilien (III., 2, p. 32) the stigmas are exaggerated, and the perianth represented as 6 instead of 5 partite. The plant was transferred by Mueller in 1863 to *Coccoloba platyclada*, F. v. M. (Curtis's Botanical Magazine, Tab., 5382), and by Meissner in 1865 to its present position. He apparently overlooked its first locality. It also occurs in New Ireland, Papua. (Mueller, Notes on Papuan plants, IV., 1876, p. 60).

PRASOPHYLLUM TEPPERI, F. v. M.

This name is accepted as valid in the Kew Index, although in the reference given (Tepper's Plants of Ardrossan, Oct., 1880) the name occurs practically as a nomen nudum without proper description, and no subsequent publication appears to have been made. Owing, perhaps, to this fact, many specimens of another later species (*P. fusco-viride*, Reader, Vict. Nat., 1898, p. 163) were placed under this species. Only a single specimen of *P. Tepperi* exists at the Herbarium, whereas *P. fusco-viride* appears to have a much wider range. To avoid future error, Mueller's MS. description is published herewith, without alteration or amendment.

"*Prasophyllum Tepperi*, Diff. a *P. brevilabre*, folio deficiente, floribus minoribus, germine turgidiore, sepalo dorsali latiore; an var.?

"Flores viriduli, Sep. dorsale lanceolato-ovatum, breviacuminatum; sep. 2 inferiora (resupinatione-superiora, lanceolata, sensim acuminata, *semiconnata*, sepalo dorsali paulo longiora, Sep. infer. (Pet.) lineari-lanceolata, sepalis exterioribus breviora, labellum aequantia; lab. brevissime unguiculatum inarticul., rhombo-ovatum, acuminatum, undulato-crispulum."

Yorke's Peninsula, Tepper, 410.

Prasophyllum fusco-viride (Reader) differs in the following respects from Prasophyllum Tepperi (F. v. M.) in:—

1. The long circular sheath which completely surrounds the inflorescence in P. Tepperi is absent in P. fusco-viride, in which there is a simple short bract at the base of the inflorescence.

2. The flower of P. Tepperi is much larger, about twice the size of P. fusco-viride.

3. The lateral sepals in P. Tepperi are united for fully half their length, whilst in fusco-viride they are only united at the extreme base.

4. The dorsal sepal in P. Tepperi is almost ovate, while in P. fusco-viride it is relatively much narrower.

5. The labellum of P. Tepperi is very shortly stipulate, and not articulate, and in P. fusco-viride the stalk of the labellum is very pronounced, and it is distinctly articulate.

6. The predominant colour of the petals of P. Tepperi is green, and of P. fusco-viride is purple.

P. fusco-viride has the following range:—Wimmera, Reader (under P. ansatum); Wimmera, Reader, 1894 (under P. Woolsii); Yorke Peninsula, S. Austr., Tepper, 1879 (under P. Tepperi).

SALICORNIA LYLEI, Ewart and White. (Chenopodiaceae).

In the description given in Journal of Proc., R.S. of N.S. Wales, vol. xlii., 1908, p. 195, for "very much branched" read "very sparsely branched."

STYLIDIUM (CANDOLLEA) YILGARNENSE, Pritzel.

Max Koch, Cowcowing, W.A., 1904, No. 1207.

This appears to be close to *S. elongatum*, and may possibly prove to be a strongly marked variety, with a more spreading panicle and the lower stalks, especially, longer. Drummond's 4th coll., No. 170, has also a shorter, looser panicle, but was placed by Bentham under *S. elongatum*. For the present, however, Pritzel's species must stand.

ADDITIONAL LOCALITIES FOR VICTORIAN PLANTS.

TILLAEA PEDICELLOSA, F. v. M. (Crassulaceae).

Geelong, H. B. Williamson, October and November, 1905.

TOXANTHUS MUELLERI, Benth. (Compositae).

Geelong, H. B. Williamson, October and November, 1905.

NATURALISED ALIENS.

BERKHEYA (STOBAEA) RIGIDA, Thunb. (Compositae).

Geelong, H. B. Williamson, 1906; Coode Island, J. R. Tovey and C. French, jnr., October, 1908.

This determination was verified at both Kew and Berlin as *Stobaea rigida*, Thunb.

Professor Hoffmann agrees with Bentham in placing Stobaea as a sub-genus to Berkheya, but no transference of this species has been made hitherto.

This pest is spreading along the shores of Port Phillip, and may therefore be considered naturalised.

CHENOPODIUM (ROUBIEVA) MULTIFIDUM, L. (Chenopodiaceae). "Scented Goosefoot."

Geelong, December, 1906, H. B. Williamson; Railway Reserve, North Melbourne, March, 1909, J. R. Tovey and C. French, jnr.

The plant is apparently naturalized around the shores of Port Phillip Bay, and is a native of South America. Introduced sparingly in the coastal districts of North America, Italy and France. It is sometimes classed as a separate genus (Roubieva). on account of the calyx enclosing the fruit, but the same peculiarity is shown by *Chenopodium ambrosioides*, L. "Mexican Tea," which has also established itself in many parts of Victoria.

RANUNCULUS REPENS, L. (Ranunculaceae). "Creeping Buttercup."

Outtrim, Victoria, 1904, Dow; Emerald, 1907, J. W. Audas, and now widely spread.

RUBUS LACINIATUS, Willd. (Rosaceae). "Jagged-leaved Bramble."

Creswick, April, 1909, Prof. Ewart; Thorpdale, Gippsland, Victoria, 1909, A. W. Vroland; near Gloucester, New S. Wales, Betche, January, 1882.

Probably sufficiently established to be considered naturalized.

This species being without definite locality, is sometimes placed under *R. fruticosus*. Its peculiar leaves and 3-fid petals, as well as minor features, appear to justify specific rank.

EXPLANATION OF PLATES.

Plates III., IV.—Acacia Mackeyana, Ewart and White.

Fig. 1.—Portion of flowering branch [natural size].
2.—Phyllode [magnified].
3.—Diagram of transverse section of a phyllode [magnified].
(a) Cuticle.
(b) Stoma.
(c) Assimilating tissue.
(d) Sclerenchyma.
(e) Phloem.
(f) Xylem.
(g) Pith.
Fig. 4.—Smaller sepal [magnified].
5.—Larger sepal [magnified].
6.—Single flower [magnified].
7.—Unripe fruit [magnified].
8, 9.—Unripe fruits [less magnified] [diagrammatic].

Plate V.—Allenia Blackiana, Ewart and Rees.

Fig. 1.—Whole plant of Allenia Blackiana. Ewart and Rees.
2.—Male Flower of same.
3.—a.b. Anther before and after dehiscing.
4.—Fruit.
5.—Seed and embryo.

Var. microphylla.

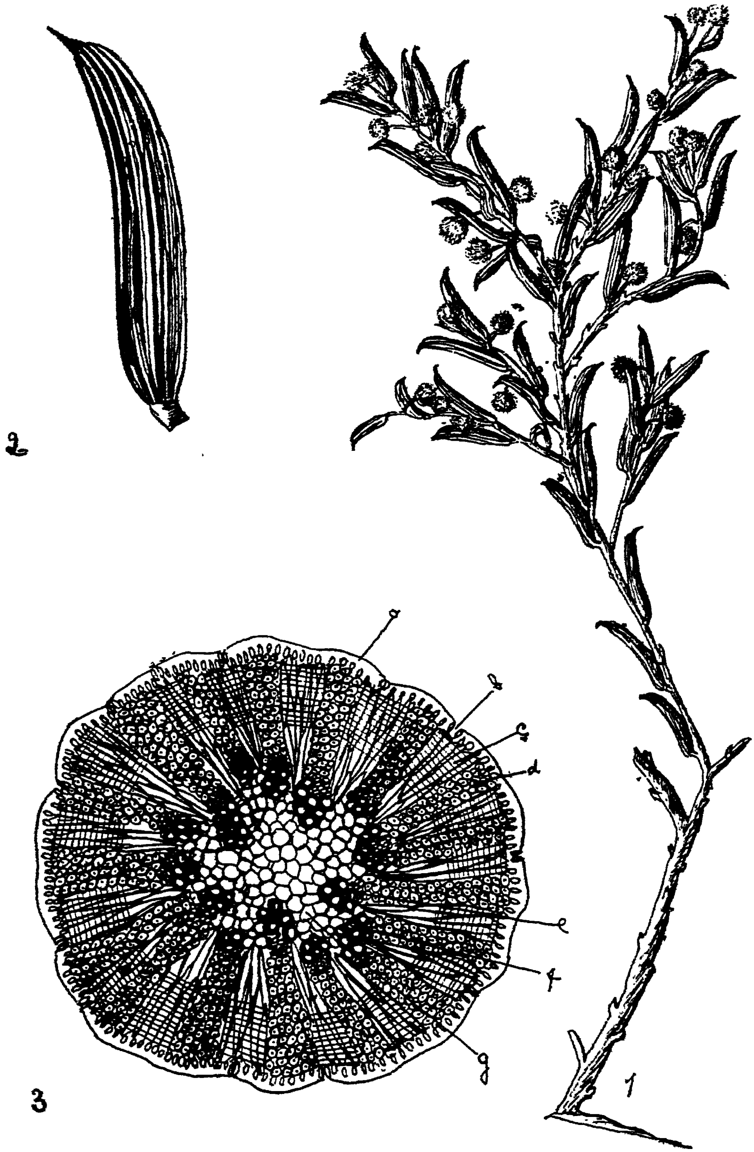
Fig. 6.—Sprig of A. Blackiana, var. microphylla.
7.—Female flower.
8.—Fruit of same.

Plate VI.—Daviesia Grahami, Ewart and White

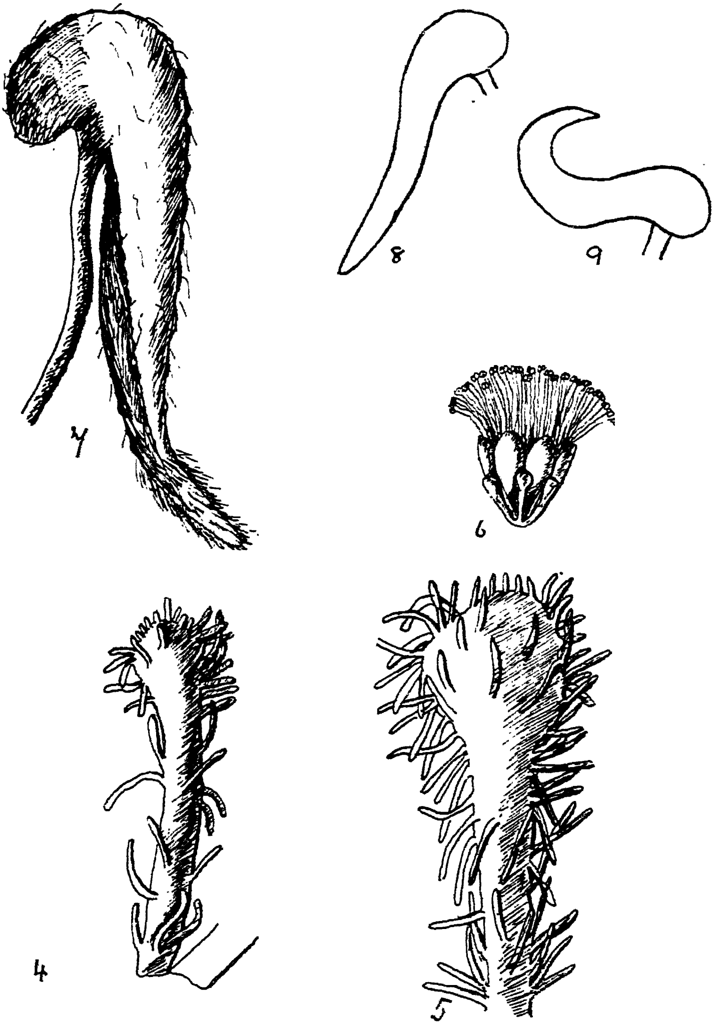
Fig. 1.—Side view of leaf.
2.—Small portion of branch showing axillary inflorescence.
3.—Calyx of D. Grahami, magnified.

D. daphnoides.

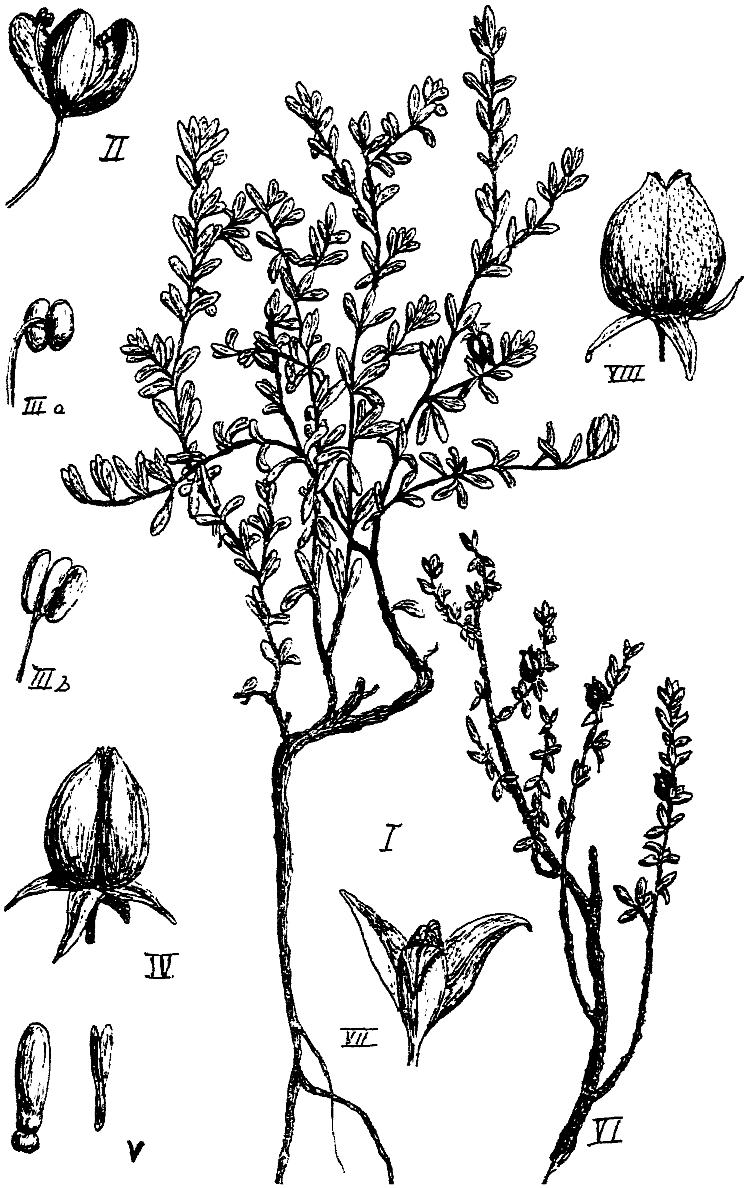
Fig. 4.—Calyx of D. daphnoides, magnified.



Acacia Mackeyana, Ewart and White.

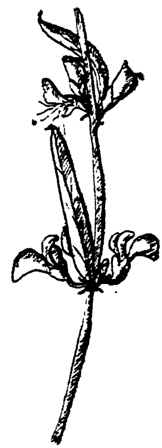


Acacia Mackeyana, Ewart and White.



Figs. 1–5.—**Allenia Blackiana,** Ewart and Rees.
Figs. 6–8.—**Allenia Blackiana,** var. microphylla, Ewart and Rees.

1



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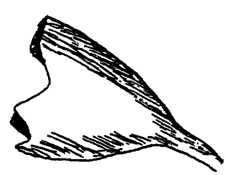

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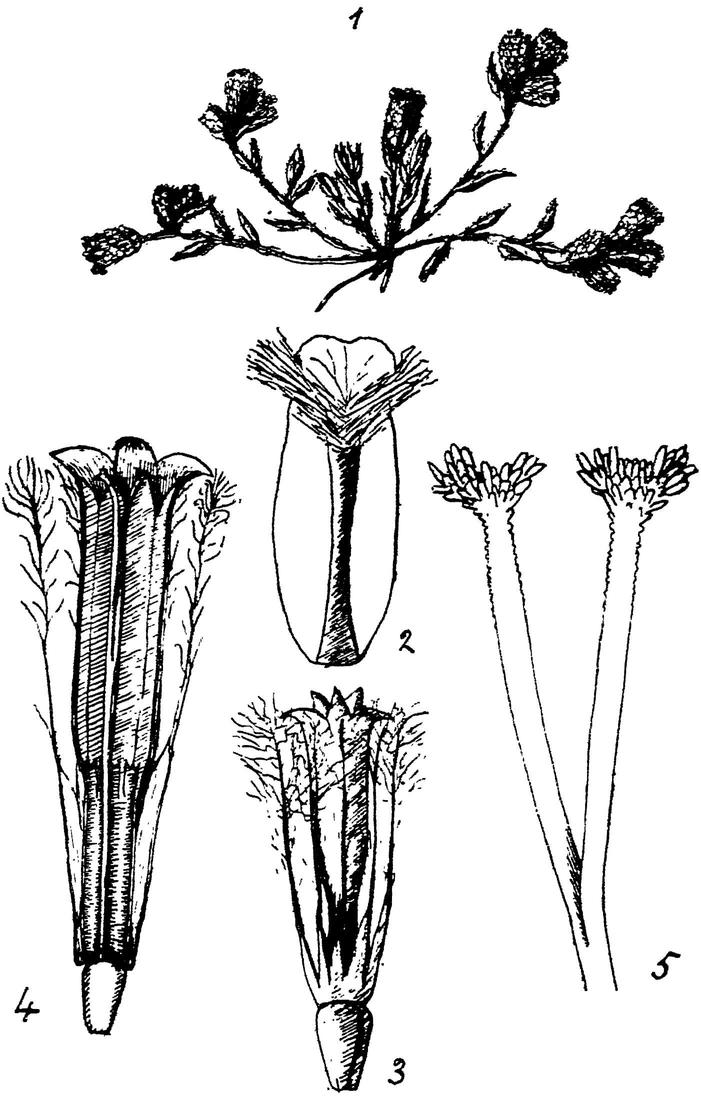
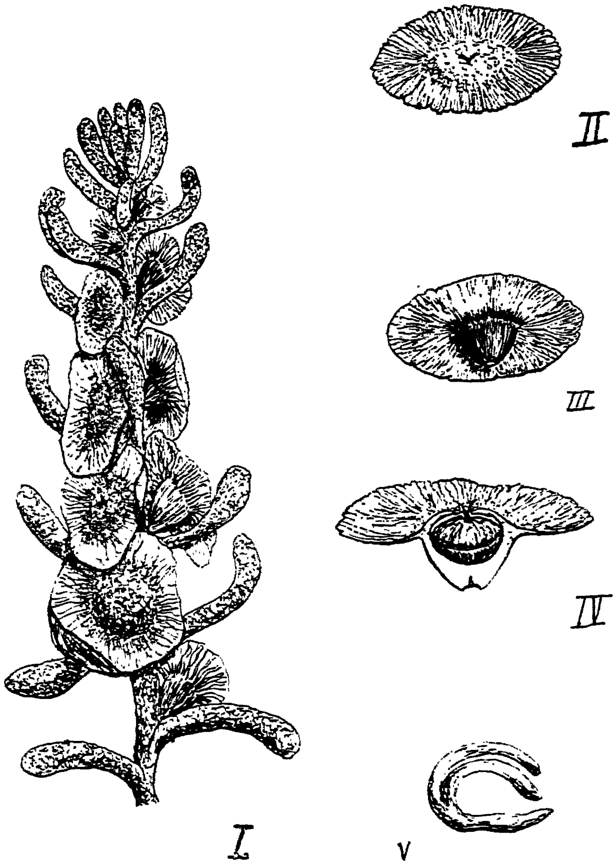
Figs. 1–3—**Daviesia Grahami**, Ewart and White.

Fig. 4—**Daviesia daphnoides**, Meisn.

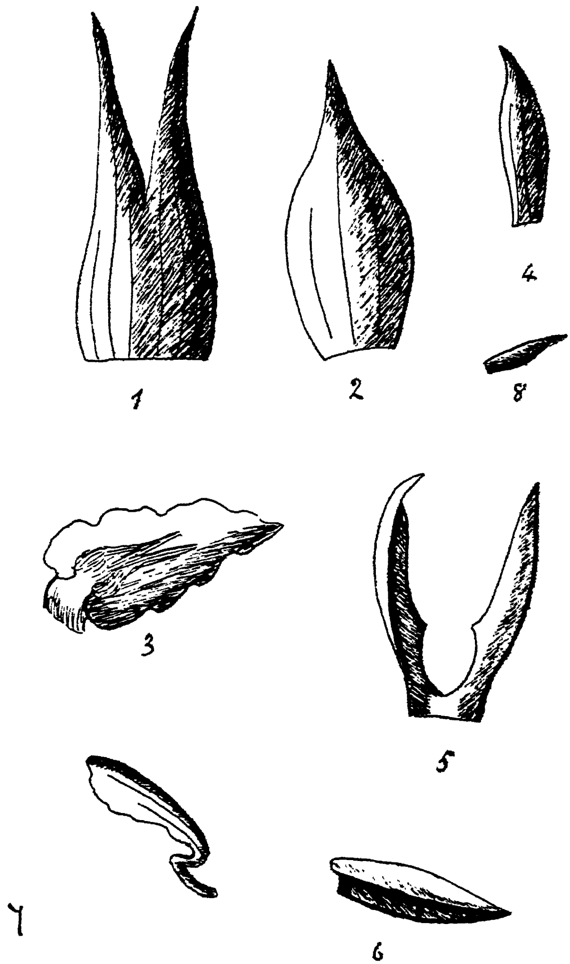


Gilruthia Osborni, Ewart and White.

Grevillea Berryana, Ewart and White.



Kochia Murrayana, Ewart and Rees.



Figs. 1-4.—**Prasophyllum Tepperi**, F. v. M.

Figs. 5-8.—**Prasophyllum fusco-viride**, Reader.

PLATE VII.—GILRUTHIA OSBORNI, Ewart and White.

Fig. 1.—Plant, natural size.
2.—Inner bract.
3.—Floret.
4.—Floret cut open.
5.—Style arms.

PLATE VIII.—GREVILLEA BERRYANA, Ewart and White.

Fig. 1.—Leaf [half natural size].
2.—Inflorescence [natural size].
3.—Single flower [magnified about 3 times].
4.—Gynæcium [magnified about 5 times] (cut open).
5.—Fruit.
(a) Wall of fruit.
(b) Seed.
(c) Wing of seed.

PLATE IX.—KOCHIA MURRAYANA, Ewart and White.

(Fig. 1-4 natural size. Fig. 5 × 2.)

Fig. 1.—Fruiting branch.
2.—Upper surface of fruit.
3.—Lower surface of fruit.
4.—Vertical section of fruit.
5.—Embryo.

PLATE X.—PRASOPHYLLUM TEPPERI, F. v. M.

Fig. 1.—Lateral sepals.
2.—Dorsal sepal.
3.—Labellum.
4.—Lateral petal.

PRASOPHYLLUM FUSCO-VIRIDE, Reader.

Fig. 5.—Lateral sepals.
6.—Dorsal sepal.
7.—Labellum.
8.—Lateral petal.

APPENDIX I., BY J. R. TOVEY.

UNRECORDED INTRODUCED PLANTS NOT YET SUFFICIENTLY ESTABLISHED TO BE CONSIDERED NATURALISED.

AMARANTHUS DEFLEXUS, L. (Amarantaceae).

Banks of the River Yarra, at Hawthorn, March, 1909, T. J. Hughes.

CISTUS SALVIFOLIUS, L. (Cistineae).

Coode Island, Victoria, J. R. Tovey, November, 1908.

DIMORPHOTHECA PLUVIALIS, Moench. (Compositae).

Coode Island, October, 1908, J. R. Tovey and C. French, jnr.

GILIA ACHILLEAEFOLIA, Benth. (Polemoniaceae).

Beaconsfield, October, 1908, C. French, jnr.

LINARIA PELISSERIANA, L. (Scrophularineae). "Pelisser's Toad-flax."

Mitta Mitta River, near Chiltern, H. B. Williamson.

MALVA MOSCHATA, L. (Malvaceae). "Musk Mallow."

Garmandale, Victoria, W. J. Power, February, 1909.

MESEMBRYANTHEMUM ANGULATUM, Thunb. (Ficoideae).

Coode Island, J. R. Tovey and C. French, jnr., October, 1908.

PHYSALIS ANGULATA, L. (Solanaceae).

Dookie, 1907 and 1909, H. Pye.

SOLANUM ELAEAGNIFOLIUM, Cav. (Solanaceae).

Railway Reserve, North Melbourne, March, 1909, J. R. Tovey and C. French, jnr.

TETRAGONA DECUMBENS, Mill. (Ficoideae).

Coode Island, October, 1908, and Railway Reserve, North Melbourne, March, 1909, J. R. Tovey and C. French, jnr.

Tetragona fruticosa, L. (Ficoideae).
Coode Island, October, 1908, J. R. Tovey and C. French, jnr.

Ursinia chrysanthemoides, Harv. (Compositae).
Coode Island, October, 1908, J. R. Tovey and C. French, jnr.

Zygophyllum sessilifolium, L. (Zygophyllaceae).
Coode Island, October, 1908, J. R. Tovey and C. French, jnr.

Additions to the Flora of the National Park, Wilson's Promontory.

The following list is supplementary to that issued in the Vict. Nat., 1909, vol. xxv., p. 142, and is partly composed of new records and partly of old ones from specimens since found in the National Herbarium. In addition Mr. Reader writes to point out that some plants recorded from the National Park in Bentham's Flora have been omitted from the list. In regard to the Beech *(Fagus Cunninghami)*, specimens have been received from the Ranger, Mr. McLennan, so that this interesting tree is still found in the Park. The first specimen of it appears to have been collected in 1853 by Baron von Mueller. The Bulrush (Typha angustifolia, L.) was found by Prof. Ewart and Dr. Hall near to the boundary of the Park, in the Darby River, so that in this case also Mr. Hardy's record was correct.

Introduced plants are marked thus (*). The record of *Grevillea Victoriae* in 1853 is of interest, since this is the only record of a Grevillea from the National Park. It is to be hoped that the plant has not been completely destroyed by the recent bush fires. A few plants were recorded from Wilson's Promontory by Gregory and Lucas (Vict. Nat., vol. ii., 1885-6, p. 150). The *Callistemon salignus* recorded by them may, however, be an error in identification for *C. lanceolatus*, while no such species as *Zanthorrhoea major* exists, *Z. australis* being probably meant. Only one plant, *Asplenium marinum*, recorded by Gregory and Lucas, was not included in the previous list.

APPENDIX II., BY J. W. AUDAS.

Supplementary List of the Flora of the National Park.

No.	Name of Plant.	Source of Record or name of Collector.
1A	Acacia longifolia, Willd., var. Sophoræ, R. Br.	J. W. Audas and P. H. R. St. John, Nov., 1908
6A	Acacia verticillata, Willd.	Do. do. do.
11A	(*) Aira caryophyllea, L.	Do. do. do.
26A	Asplenium marinum, L.	J. B. Gregory and A. H. S. Lucas, 1885-6
30A	Atriplex cinerea, Poir.	A. D. Hardy, Dec. 1905
42A	Billardiera longiflora, Labill.	Miss W. Falls, June, 1909
48A	(*) Briza minor, L.	J. W. Audas and P. H. R. St. John, Nov., 1908
48B	(*) Briza maxima, L.	Do. do. do.
56A	Caladenia Cairnsiana, F. v. M.	Do. do. do.
65A	(*) Carduus lanceolatus, L.	Do. do. do.
65B	Carex canescens, L.	In Flora Austr., coll. by F. v. M., 1853
75A	Cheilanthes tenuifolia, Sw.	C. McLennan, 23rd Feb., 1909
75B	Chenopodium glaucum, L.	A. D. Hardy, Dec., 1905
90A	Cryptostylis leptochila, F. v. M.	C. McLennan (Ranger), Feb., 1909
91A	Cyathodes acerosa, R. Br. (Styphelia oxycedrus Lab.)	Coll. by F. v. M., Aug., 1854; Miss Fall, May, 1909
116A	Elaeocarpus cyaneus, Sims	In Flora Austr., coll. by F. v. M., 1853
122A	Eriostemon myoporoides, D. C.	Do. do. do.

* Naturalized aliens.

No	Name of Plant.	Source of Record or name of Collector.
134	Fagus Cunninghami, Hook	Coll. by F. v. M., 1853; also by Ranger, Feb., 1908
135A	(*) Festuca rigida, Kunth.	J. W. Audas and P. H. R. St. John, Nov., 1908
136A	Galium australe, D. C.	Do. do. do.
147A	Grevillea Victoriae, F. v. M.	In Nat. Herbarium, coll. by F. v. M., 1853
160A	Helichrysum cuneifolium, F. v. M.	Do. do. do.
170A	(*) Holcus lanatus, L.	J. W. Audas and P. H. R. St. John, Nov., 1908
170B	Hydrocotyle hirta, R. Br.	Do. do. do.
171A	Hydrocotyle tripartita, R. Br.	A. D. Hardy, Dec., 1905
182A	Juncus planifolius, R. Br.	J. W. Audas and P. H. R. St. John, Nov., 1908
197A	Leucopogon Maccraei, F. v. M.	In Flora Austr., coll., by F. v. M., 1853
197B	Leucopogon Richei, R. Br.	In Nat. Herbarium, coll. by F. v. M., 1853
		J. W. Audas and P. H. R. St. John, Nov., 1908
189A	Lepidosperma laterale, R. Br.	In Nat. Herbarium, coll. by F. v. M., 1853
189B	Lepidosperma Neesii, Kunth.	Do. do. do.
203A	(*) Lolium perenne, L.	J. W. Audas and P. H. R. St. John, Nov., 1908
209A	Luzula campestris, D. C.	Do. do. do.
213A	Lythrum Salicaria, L.	Do. do. do.
213B	(*) Malva rotundifolia, L.	Do. do. do.
218A	(*) Melilotus parviflora, Desf.	Do. do. do.
219A	Mentha gracilis, R.Br., var. serpyllifolia, Benth.	In Nat. Herbarium, coll by F. v. M., 1853
219B	Mentha laxiflora, Benth.	C. McLennan (Ranger), Feb., 1909
224A	Monotoca elliptica, R. Br.	In Flora Austr., coll. by F. v. M., 1853
225A	Myoporum insulare, R. Br.	J. W. Audas, and P. H. R. St. John, Nov., 1908

* Naturalized aliens.

No.	Name of Plant.	Source of Record or name of Collector.
226A	Myosotis suaveolens, Poir.	J. W. Audas, and P. H. R. St. John, Nov., 1908
228A	Notelaea ligustrina, Vent.	In Nat. Herbarium, coll. by F. v. M., 1853
230A	Olearia glutinosa, Benth.	In Nat. Herbarium, coll. by F. v. M., 1853
247A	Pimelea drupacea, Labill.	In Flora Austr., coll. by F. v. M., 1853
254A	Plantago major, L.	J. W. Audas and P. H. R. St. John, Nov., 1908
268A	Potentilla Anserina, L.	In Flora Austr., coll. by F. v. M., 1853
282A	Pultenaea tenuifolia, R. Br.	J. W. Audas and P. H. R. St. John, Nov., 1908
292A	Rumex bidens, R. Br.	Do. do. do.
292B	Salicornia australis, Soland.	A. D. Hardy, Dec., 1905; Prof. Ewart, Jan., 1909
298A	Scirpus arenarius, Benth.	In Flora Austr., coll. by F. v. M., 1853
302A	Selliera radicans, Cav.	A. D. Hardy, Dec., 1905
313A	Sprengelia incarnata, Sm.	J. W. Audas and P. H. R. St. John, Nov., 1908
318A	Stellaria pungens, Brong.	Do. do. do.
345	(*) Trifolium repens, L.	Do. do. do.
345	Typha angustifolia, L.	A. D. Hardy, Dec., 1905; Prof. Ewart, Jan., 1909
345A	Uncinia tenella, R. Br.	In Flora Austr., coll. by F. v. M., 1853
350A	Veronica nivea, Lindl.	Do. do. do.
351A	(*) Vicia sativa, L.	J. W. Audas and P. H. R. St. John, Nov., 1908
357A	(*) Xanthium spinosum, L.	Do. do. do.

* Naturalized aliens.

[Proc. Roy. Soc. Victoria, 22 (N.S.), Pt. I., 1909.]

Art. III.—*Description of Two Terrestrial Species of Talitridae from Victoria.*

By O. A. SAYCE.

(With Plates XI., XII.)

[Read 13th May, 1909.]

The only terrestrial Amphipod so far recorded as occurring in Australia and Tasmania is *Talitrus sylvaticus*, Haswell. I have received specimens from New South Wales, Tasmania, and many parts of Victoria, ranging from the seaboard to the tops of our highest mountains, and they all agree closely with one another morphologically. The original description is somewhat meagre in the light of what is now known of the genus, so that I have in this treatise more fully described it.

Another well-defined species referable to the same genus is to be met with commonly throughout the forest lands of Victoria, outside of which it has not so far been found. I herewith give a description of it.

The characters of each of these species are mostly in close agreement with other members of the genus *Talitrus*, the most important variation being in the shape of the palp of the maxillipeds, which possesses a rudimentary but definite fourth joint, clearly marked off from the preceding one by a line of articulation in *T. sylvaticus*, whereas in *T. kershawi* it is coalescent, but of the same conical shape and tipped with a single long spinule. Another character of difference worthy of note is that the carpal joint of the first gnathopod is somewhat expanded, whereas typically it is elongated and linear in form.

Talitrus sylvaticus, Haswell.

(Plate XI.)

T. sylvaticus, Haswell. Proc. Linn. Soc. N.S.W., vol. iv., p. 245, pl. vii., fig. 1.

T. assimilis, Haswell. Proc. Linn. Soc. N.S.W., vol. v., p. 97, pl. 5, fig. 1.

T. assimilis and T. affinis, Haswell. Proc. Linn. Soc. N.S.W., vol. x., p. 95, pl. x., fig. 1.

T. sylvaticus, G. M. Thomson. Proc. Roy. Soc. Tas. 1892, p. 15, figs. 1-10.

T. sylvaticus, Sayce. Proc. Roy. Soc. Vict., xiii. (n.s.), pl. ii., p. 225.

Body smooth and rather slender, cephalon as long as the first and half of the second segment of mesosome combined. First pair of side-plates distinctly narrowing distally. Third pair of epimeral plates of metasome with margin below slightly and evenly curved, antero-lateral corners evenly rounded; postero-lateral corners right-angled and margin above minutely crenulated. Branchiae vesicular, large, remarkably so on the second gnathopoda and fourth pereiopoda, the latter bilobed proximally. Incubatory lamellae very small, lanceolate, with a few setae at the distal extremity.

Upper antennae, extending to the middle of the last peduncular joint of the lower pair; the flagellum of subequal length to the peduncle.

Lower antennae, varying in length considerably in specimens from different localities; usually long and slender, last joint of peduncle almost twice as long as the preceding one, no perceptible sexual difference.

Upper lip large and prominent, broadly rounded distally.

Mandibles, without any trace of palp; that of right-hand side with the cutting edge containing four teeth, and the secondary plate bidentate; that of the left-hand side with the cutting edge of six teeth, and the secondary plate with a single series of four teeth. In each the molar tubercle is very large, and set with numerous rows of stout denticles; the spine-row has about four plumose setæ, and near their base is a tuft of fine cilia.

Lower lip, membranous, lobes wide, and broadly rounded distally.

First maxillae.—Inner plate narrow, extending nearly to the end of the outer plate, and tipped with two plumose spinules; outer-plate broad, and bearing apically a double series of nine denticulated spines. Palp formed of one well-defined minute joint, tipped with the vestige of a second one.

Second maxillae.—Inner and outer plates broad and almost of similar length to each other; each fringed distally with simple spinules, besides which the inner plate bears a long, stout, feathered spine at the distal extremity of the inner margin.

Maxillipeds.—Outer masticatory plates small, each broad proximally, but rapidly narrowing to a bluntly pointed apex directed obliquely inwards, and bearing, submarginally, a single transverse row of short stiff setæ. Inner plates of usual form, each bearing at the extremity two large teeth, and one small one, also a few plumose setæ. Palp of four joints, the ultimate one being minute, and of conical shape, tipped with a long spinule. It is usual for the members of this genus to have but three joints in the palp, the fourth wanting or entirely coalescent with the third, but in this species it is clearly marked off by a distinct line of division from the previous one.

Gnathopoda.—First pair with carpus expanded distally, and fully twice as long as its greatest breadth; propodus shorter in length, and gradually narrowing to the dactylus. The second pair agreeing in both sexes, of similar form to others of the same genus, and without any specific characteristic.

Pereiopoda.—The first and second pairs similar to each other and much longer than the gnathopoda. Third of equal length to the preceding ones; the fourth and fifth subequal in length to each other, much longer than the preceding ones. Basos of last pair widely expanded behind, with margin minutely serrated.

Pleopoda.—Only first and second pairs existing, and, as in other terrestrial amphipoda, these are more or less atrophied from disuse. Relative to the following species they are well developed—First pair very short with two well-developed rami, the outer one (exopod) a little longer than the inner

one (endopod), which is of equal length to the peduncle, and each is fringed with long feathered setæ. Second pair considerably shorter than the first, but of similar form and clothing. No vestige of a third pair is to be found.

Uropoda.—In the first and second pairs the peduncle extends at least as far as the end of the telson, the third pair, two jointed, minute, and of normal form.

Telson.—Broad at the base, and curving to a narrowly truncated tip, margin entire, and the surface bearing a few little setæ.

Sexes.—No apparent sexual difference.

Colour when alive variable, usually dark brown, but sometimes reddish-brown, and occasionally pale yellow.

Length.—The largest specimen measured from front of head to telson, 12 mm., but in most of the gatherings they measured about 8 mm.

Occurrence.—Very common throughout Victoria at all elevations, under logs and dead leaves in forest and scrub lands, preferably in damp situations, but also frequently in dry places, and often in association with the following species. I have also found them just above the tide-level at several places on our coast, under dead seaweed, lying on sand.

Distribution.—Very common in Tasmania, and relatively in fewer numbers along the coastal and mountainous regions of New South Wales.

Talitrus kershawi, n. sp.

(PLATE XII.)

Body rather stouter and usually of a larger size than the preceding species. Cephalon scarcely longer than the first segment of the mesosome. First pair of side-plates subquadrate, quite as wide distally as proximally, antero-distal corner abruptly rounded, postero-distal corner broadly rounded, and margin between almost straight. Third pair of epimeral plates of metasome with antero-lateral corner produced downwards to a conspicuous triangular projection, the posterior corner being right-angled, and hind margin minutely crenulated.

Antennae agreeing essentially with the previous species in relative length and form.

Buccal area.—The anterior and posterior lips, and first and second maxillae, agree precisely with the former species, the mandibles only differ slightly in the teeth of the cutting edges. The maxillipeds have the ultimate joint (dactylus) of the palp coalescent with the penultimate one (propodus), and terminates in a minute conical piece (the remnant of the dactylus), possessing one or two spinules, and at the apex a long single spinule. Except for this difference the palp agrees closely with *T. sylvaticus.* The inner masticatory plate quite agrees with that species, and the outer plate also agrees in form, except that the apex is rather broader, distinctly indented, and clothed with two tufts of setæ, separated by the indentation.

Gnathopoda.—The first pair has the carpus widely expanded distally, being fully three-quarters as wide as its length, and is minutely but distinctly lobed. The second pair is without any special characteristic, and quite normal to the genus. Like the previous species, there are very large branchiae attached.

Pereiopoda.—These are rather more spinulose than *T. sylvaticus,* and possess rather smaller branchiae. The incubatory lamellae are similar, and in all other respects are in close agreement.

Pleopoda.—These are quite rudimentary, much more so than in the preceding species. The first pair has a stout peduncle, with a single minute outer ramus articulated to the stem subapically. Beyond the articulation of this ramus the peduncle is produced a little at the apex, evidently the vestige of the inner ramus, but it is quite coalescent with the stem. The second pair exist only as a minute cylindrical process, being but a vestige of a former peduncle. Each pair possess a few little setules, but no feathered setæ.

Uropoda.—These agree in form and armature with the preceding species, but are relatively rather shorter and stouter.

Telson.—Quite similar to the preceding species.

Sexes.—There is no apparent sexual differentiation.

Colour.—Varying from reddish-brown to black, and sometimes pale yellow.

Length.—The largest measured 15 mm. in length, but are usually about 11 mm.

Occurrence.—I have gatherings from a considerable number of localities throughout Victoria. They are often associated with *T. sylvaticus*, and rather more numerous than that species.

Distribution.—Out of Victoria it does not appear to have been observed.

Remarks.—The specific name is given in compliment to Mr. J. A. Kershaw, curator of the National Museum.

It may easily be distinguished from *T. sylvaticus* by the conspicuous triangular downward projection of the epimeral plate of the third segment of the metasome (noticeable in the smallest specimens), and also by the rectangular form of the first coxal plate, which in *T. sylvaticus* is distinctly narrower distally than proximally.

EXPLANATION OF PLATES.

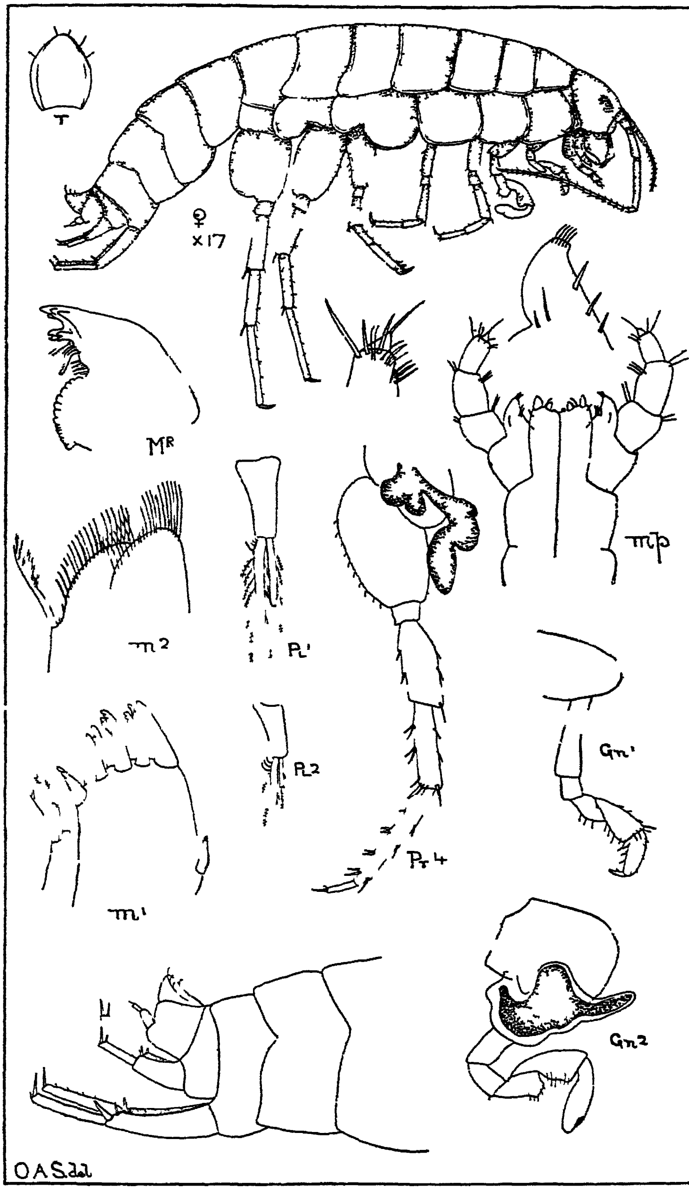
PLATE XI.

Talitrus sylvaticus, Haswell.

PLATE XII.

Talitrus kershawi, n. sp.

The following lettering is used in each of the plates to designate the corresponding parts:—m^1. first maxillae; m^2. second maxillae; *mp*. maxillipeds; Gn^1 and Gn^2. first and second pair of gnathopods; Pr^4. fourth pair of peraeopods; Pl^1., Pl^2. first and second pair of pleopods; *T*. telson.



Talitrus sylvaticus, Hasw

ART. IV.—*Description of a New Marine Shell of the Genus Larina.(?)*

BY J. H. GATLIFF AND C. J. GABRIEL.

(With Plate XIII.)

[Read 10th June, 1909.]

Larina (?) turbinata, sp. nov.

Shell fragile, turbinate, umbilicate, white, semi-transparent, vitreous interiorly, whorls six, including the minute embryonic apex of two whorls, which are of a brown colour and appear to be smooth, but under the microscope they are densely spirally pitted. Whorls very rapidly increasing, the last and penultimate comprising nearly the whole of the shell, the whorls are ventricose, suture deeply impressed. Sculpture, faint; under the lens it is densely, irregularly, spirally striate, the striae being somewhat undulating, and crossed by growth lines of about similar strength.

The mouth is circular, peristome continuous, slightly reflexed; umbilicus small, deep, almost hidden by the reflexion of the lip.

The shell is partly covered with an olivaceous epidermis.

The operculum of the type was lost, but a microscopic examination of the embryonic form shows a horny operculum, annular, and with the nucleus intramarginal.

Dimensions of Type.—Height, 15 mm.; width, 16 mm.; width of radula, .54 mm.; embryonic forms, height .625 mm., width .597 mm.

Hab.—Dredged in about five fathoms, between Phillip and French Islands, Western Port.

Obs.—The genus Larina was established by A. Adams for a shell obtained at Moreton Bay, Queensland, and he included it in the family Viviparidae. When obtained our type had the animal in it, which, upon extraction, was found to contain about

400 embryonic shells, most of which are shown in Figure 3 Upon another occasion an almost entire, empty shell was dredged, and at other times a half-grown specimen and portions of the shell have been similarly obtained.

Judging from the description and figure (we have not seen the type) the main points of difference in our shell when compared with the typical Larina are: ours is umbilicate and the peristome is continuous; and in consequence of these differences we have only placed it provisionally in the genus.

A very incomplete half-grown specimen has been sent to us by Miss Lodder, Tasmania; it was found by her years ago on the North Coast.

Mr. E. A. Smith remarks[1]: "The genus Larina supposed by Adams to be marine; it has, however, very close relationship to Vivipara on account of similarity of the opercula, and it is undoubtedly a fresh-water form, as is clearly shown in the British Museum specimen obtained in McKenzie River by the Port Essington Expedition during the year 1845" The question arises, Was it obtained at a portion of the river beyond tidal influence? Our specimens were dredged in the sea fully a mile from the shore, and there are no running streams in the vicinity.

We are indebted to Mr. F. Chapman, of the National Museum, Melbourne, for his skilful work in photographing the specimens.

Type in Mr. C. J. Gabriel's collection.

EXPLANATION OF PLATE XIII.

LARINA (?) TURBINATA, sp. nov.

Fig. 1.—Position of body whorl of embryonic form.

Fig. 2.—Radula of type.

Fig. 3.—Group of embryonic forms.

Fig. 4.—Embryonic forms.

Fig. 5.—Dorsal aspect of type.

Fig. 6.—Front aspect of type.

Fig. 7.—Basal aspect of type.

All of the figures variously magnified.

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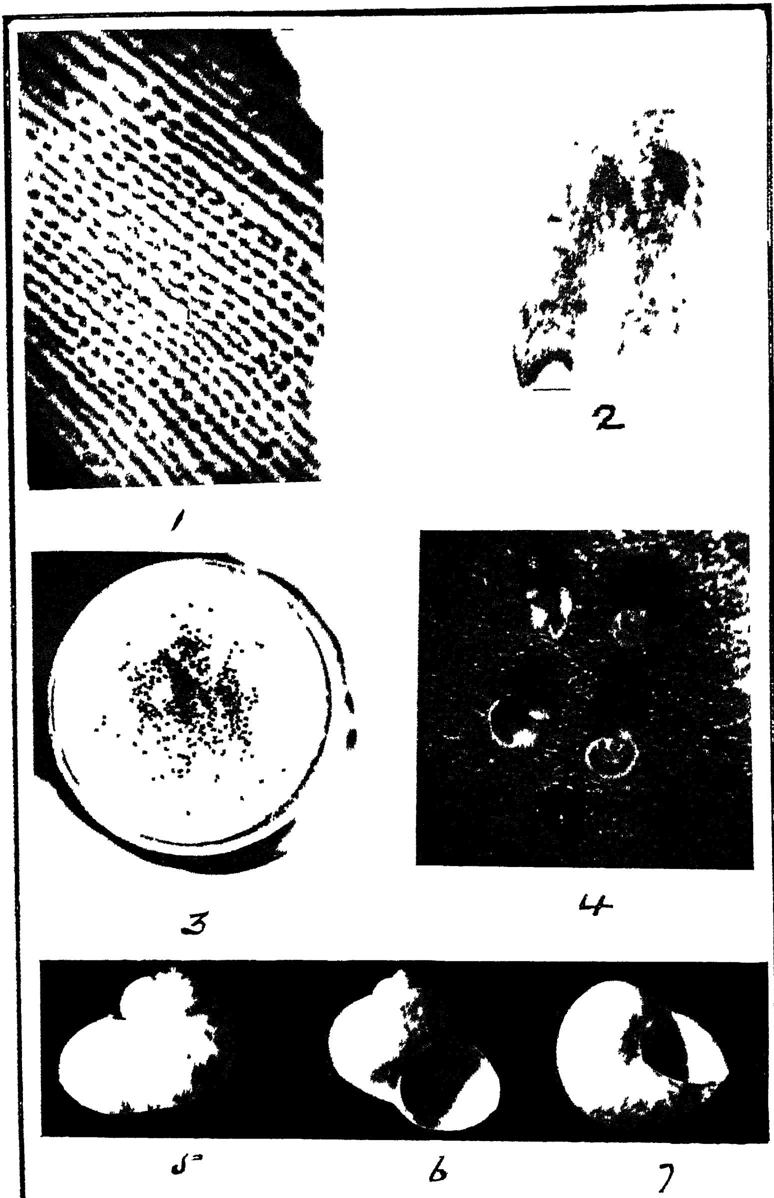
1 Journ. Linn. Soc., Lond., 1882, vol. xvi., p. 266



Larina turbinata, sp nov.

[Proc. Roy. Soc. Victoria, 22 (N.S.), Pt I., 1909.]

Art. V.—*Additions to the Catalogue of the Marine Shells of Victoria.*

By J. H. GATLIFF and C. J. GABRIEL.

[Read 10th June, 1909.]

In the previous parts of the Catalogue, 840 species have been dealt with; the present paper records 36 additional species, including four more genera, namely, Teinostoma, Pugnus, Larina and Bornia.

We hope to make many additions to the Catalogue from the material being obtained by the Commonwealth Trawler "Endeavour."

Sepia braggi, Verco.

1907. Sepia braggi, Verco. T.R.S. S.A., vol. xxxi., p. 213, pl. 27, f. 6, 6a, 6b, 6c, 6d.

1908. Sepia braggi, Hedley. Rec. Aust. Mus., vol. vii.

Hab.—Heytesbury Coast (G. B. Pritchard).

Obs.—The form of this cuttlebone is narrow. Size of type, "60 mm. long by 11 mm. broad at its widest part, with a maximum thickness of 4.75 mm."

Marginella allporti, T. Woods.

1876. Marginella allporti, T. Woods. P.R.S. Tas., p. 28.

1901. Marginella allporti, Tate and May. P.L.S. N.S.W., p. 362, pl. 26, f. 80.

Hab.—Bass Strait.

Obs.—Size of type: Length 9, breadth 5 mm.; a biconic, banded form, quadriplicate.

Daphnella cassandra, Hedley.

1904. Daphnella cassandra, Hedley. P.L.S. N.S.W., vol. xxix., p. 187, pl. 8, f. 17.

Hab.—Port Albert (T. Worcester).

Vanikoro recluziana, Adams and Angas.

1863. Vanicoro reculziana, Adams and Angas. P.Z.S Lond., p. 424.
1867. Vanikoro recluziana, Angas. P.Z.S. Lond., p. 212.
1884. Vanikoro recluziana, Sowerby. Thes. Conch., vol. v., p. 170, f. 2.
1908. Vanikoro recluziana, Smith. P. Mal. S. Lond., vol. viii., p. 112.

Hab.—Portland (T. Worcester).

Obs.—In his review of the genus Vanikoro, Mr. E. A. Smith, in the paper above quoted, remarking upon Vanikoro sigaretiformis, Potiez and Michaud, says he thinks there is very little doubt that it is the same species as V. recluziana.

Calyptraea scutum, Lesson.

1830. Trochita scutum, Lesson. Voy. Coquille, Zool., vol. ii., p. 395.
1880. Trochita scutum, Hutton. Man. N.Z. Moll., p. 86.

Hab.—Dredged between Phillip and French Islands, Western Port; Port Albert (T. Worcester).

Obs.—By its almost central and conical spire, it may be readily separated from our other species, C. calyptraeformis.

Turritella atkinsoni, Tate and May.

1877. Turritella tasmanica, T. Woods (non Reeve). P.R.S. Tas., p. 140.
1900. Turritella atkinsoni, Tate and May. T.R.S. S.A., p. 95.
1901. Turritella atkinsoni, Tate and May. P.L.S. N.S.W., vol. xxvi., p. 378, pl. 23, f. 15-17.

Hab.—Bass Strait.

Turritella sinuata, Reeve.

1849. Turritella sinuata, Reeve. Conch. Icon., vol. v., pl. 11, f. 62.

1900. Turritella quadrata, Donald. P. Mal. Soc., vol. iv., p. 53, pl. 5, f. 8, 8a, 8b.

Hab.—Port Albert (T. Worcester).

Turritella smithiana, Donald.

1900. Turritella (Colpospira) smithiana, Donald. P. Mal. Soc., vol. iv., p 52, pl. 5, f. 1—1c.

Hab.—San Remo (T. Worcester).

Obs.—Our smallest species in the genus.

Scala morchi, Angas.

1871. Scala (Cirostrema) morchi, Angas. P.Z.S. Lond., p. 15, pl. 1, f. 17.

1906. Scala morchi, Verco. T.R.S. S.A., vol. xxx. p. 147, pl. 4, f. 1-2 (Operculum).

Hab.—Western Port (T. Worcester).

Obs.—This may be readily separated from S. translucida, Gatliff, by its rounded base, much finer sculpture, and the absence of the encircling basal ridge.

Eulima topaziaca, Hedley.

1908. Eulima topaziaca, Hedley. P.L.S. N.S.W., vol. xxxiii., p. 470, pl. 10, f. 29.

Hab.—Western Port ; Port Albert (T. Worcester).

Obs.—Mr. Hedley observes: "The shape of this eccentric Eulima is like that of a Rissoa." We agree with him, and think it will have to be re-classified. A semi-transparent shell when fresh usually of a brown colour, weathering into opaque white.

Leiostraca lodderae, Hedley.

1884. Eulima vitrea, Petterd. Jour. of Conch., vol. iv., p. 136 (non A. Adams, 1854).

1903. Leiostraca lodderae, Hedley. Mem. Aust. Mus., vol. iv., p. 360, f. 82.

Hab.—Western Port.

Obs.—A small species; type: Length 7.7, breadth 1.2 mm.; usually banded.

Turbonilla acicularis, Adams.

1853. Turbonilla acicularis, Adams. P.Z.S. Lond., p. 182.

1877. Turbonilla macleayana, T. Woods. P.R.S. Tas., p. 151.

1886. Turbonilla macleayana, Tryon., Man. Conch. vol. viii., p. 334, pl. 76, f. 44.

1901. Turbonilla acicularis, Tate and May. P.L.S N.S.W., vol. xxvi., p. 384.

Hab.—Dredged off Portsea, Port Phillip; also Western Port; Port Albert (T. Worcester).

Obs.—Kindly compared with the type of T. acicularis in the British Museum by Mr. E. A. Smith. Pritchard and Gatliff considered it to be a narrow and small form of T. mariae (T. Woods), which it much resembles.

Larina turbinata, Gatliff and Gabriel.

1909. Larina turbinata, Gatliff and Gabriel. Ante page.

Hab.—Dredged, Western Port.

Genus **TEINOSTOMA,** H. and A. Adams, 1853.

Teinostoma cancellata, Tate.

1879. Ethalia (?) cancellata, Tate. T.R.S. S.A., vol. ii., p. 139, pl. 5, f. 11a-11c.

Hab.—Port Albert (T. Worcester).

Rissoa dissimilis, Watson.

1877. Rissoina cylindracea, T. Woods. P.L.S. N.S.W., p. 266, (non Krynicki, 1837).

1886. Eulima dissimilis, Watson. Chall. Zool., vol. xv., p. 522, pl. 37, f. 5.

1899. Rissoia ischna, Tate (nom. mut. instead of R. cylindracea). T.R.S. S.A., p. 233.

1901. Rissoia dissimilis, Tate and May. P.L.S. N.S.W., vol. xxvi., p. 391.

Hab.—Port Fairy.

Obs.—In the last reference above quoted, Tate and May wrongly cited Eulima tasmanica, T. Woods, as conspecific, but subsequently in P.R.S. Tas., 1902, p. 110, May corrected the mistake.

Rissoa incompleta. Hedley.

1908. Rissoa incompleta, Hedley. P.L.S. N.S.W., vol. xxxiii., p. 468, pl. 10, f. 36.

Hab.—Dredged in about 5 fathoms between Phillip and French Islands, Western Port.

Rissoa imbrex, Hedley.

1908. Rissoa imbrex, Hedley. P.L.S. N.S.W., vol. xxxiii., p. 469, pl. 10, f. 33.

Hab.—In shell sand, San Remo, Western Port.

Obs.—A small elongate white shell, with encircling ridges, two on the penultimate whorl.

Rissoa devecta, Tate.

1877. Alvania gracilis, Angas (non MacGillivray). P.Z.S. Lond., p. 174, pl. 26, f. 16.

1887. Alvania gracilis, Tryon. Man. Conch., vol. ix., p. 364, pl. 66, f. 47.

1899. Rissoia devecta, Tate (nom. mutand). T.R.S. S.A., vol. xxiii., p. 235.

Hab.—In shell sand, Ocean Beach, Flinders.

Obs.—A brown elongate shell, sometimes banded with white.

Rissoina hedleyi, Tate.

1899. Rissoina hedleyi, Tate. T.R.S. S.A., vol. xxiii., p. 241, pl. 7, f. 8.

Hab.—Western Port.

Obs.—Prof. Tate states that he received this species from Dr. Pulleine, obtained by the latter at "Port Western, Victoria."

Rissopsis buliminoides, Tate and May.

1900. Rissopsis buliminoides, Tate and May. T.R.S. S.A., vol. xxiv., p. 101.

1901. Rissopsis buliminoides, Tate and May. P.L.S. N.S.W., vol. xxvi., p. 394, pl. 26, f. 75.

Hab.—Port Albert (T. Worcester).

Obs.—"Shell small, cylindroid, thin, opaque-white"; size of type: Length, 4.25; breadth, 1.3 mm.

Rissopsis consobrina, Tate and May.

1900. Rissopsis consobrina, Tate and May. T.R.S. S.A., vol. xxiv., p. 101.

1901. Rissopsis consobrina, Tate and May. P.L.S. N.S.W., vol. xxvi., p. 394, pl. 27, f. 94.

Hab.—In shell sand, Ocean Beach, Point Nepean.

Obs.—The shell is hyaline, turreted, and has rounded whorls. Size of type: Length, 3.5; width, 1.0 mm.

Gibbula tasmanica, Petterd.

1879. Gibbula tasmanica, Petterd. Jour. of Conch., vol. ii., p. 103.

1889. Gibbula tasmanica, Tryon. Man. Conch., vol. xi., p. 237, pl. 40, f. 20.

Hab.—Bass Strait.

Obs.—A small shell about the size of G. legrandi, Petterd, but it has spiral lirae. Our two specimens are of a rose colour.

Plaxiphora glauca, Quoy and Gaimard.

1834. Chiton glaucus, Quoy and Gaimard. Astrolabe, Zool., vol. iii., p. 376, pl. 74, f. 7-11.

1892. Plaxiphora glauca, Pilsbry. Tryon's Man. Conch., vol. xiv., p. 325, pl. 68, f. 68-72.

1897. Plaxiphora glauca, Bednall. P. Mal. S. Lond., vol. ii., p. 154.

Hab.—Kilcunda.

Obs.—Very similar to P. petholata, Sowerby. Pilsbry surmises that P. glauca "is probably the form Angas collected at Guichen Bay, South Australia, and listed as P. ciliata," and Bednall considers he is right in his surmise.

Acanthochites coxi, Pilsbry.

1894. Acanthochites coxi, Pilsbry. Proc. Acad. Nat. Sci. Philadelphia, p. 80, pl. 3, f. 21-26, and pl. 4, f. 34.

Hab.—Dredged, Western Port.

Obs.—The description states, "Girdle fleshy, densely clothed with short hyaline spinelets, the tufts being represented by inconspicuous clumps of somewhat longer spines." The size of type is: "Length 23, breadth 13 mm. (alcoholic specimen)." Our single specimen is not quite one third of these dimensions.

Genus PUGNUS, Hedley, 1896.

Pugnus parvus, Hedley.

1896. Pugnus parvus, Hedley. Records Aust. Mus., vol. ii., p. 5, pl. 23. f. 1.

Hab.—Bass Strait.

Obs.—The size of the type is: Length 1⅓, breadth 1 mm. This minute shell in shape resembles a Cylichna, but may be readily distinguished from that genus by the absence of an umbilicus at the top, the presence of three folds on the columella, and a thickened outer lip. It is decussately sculptured. Mr. Hedley has placed the genus in the family Ringiculidae.

Philine columnaria, Hedley and May.

1908. Philine columnaria, Hedley and May. Rec. Australian Museum, vol. vii., p. 123, pl. 24, f. 25, 26.

Hab.—Dredged, Western Port (alive).

Obs.—A small milk white species; size of type: length 6.5, breadth 5 mm. Compared with P. angasi, "it is more trapezoidal, has distinct spiral lines, and an axial hollow above." Our identification has been confirmed by Mr. May.

Dentalium platyceras, Sharp and Pilsbry.

1898. Dentalium platyceras, Sharp and Pilsbry. Man. Conch., vol. xvii., p. 126, pl. 22, f. 58-60.

Hab.—Port Albert (T. Worcester).

Corbula coxi, Pilsbry.

1897. Corbula coxi, Pilsbry. Proc. Acad. Nat. Sci. Philadelphia, p. 363, pl. 9, f. 1-3.

Hab.—Port Phillip: Western Port; Port Albert (T. Worcester).

Obs.—The concentric sculpture in this species is much finer than in C. tunicata, Hinds., and it is about the same size.

Circe (Crista) navigatum, Hedley.

1906. Gafrarium navigatum, Hedley. P.L.S. N.S.W., vol. xxxi., p. 476, pl. 38, f. 33.

Hab.—Dredged in about 6 fathoms between Phillip and French Islands, Western Port. One valve only was found.

Obs.—A small species. Size of type: Length 6 mm., height 5.4 mm., breadth of single valve 1.6 mm. Compared by one of us with the type.

Circe angasi, Smith.

1865. Gouldia australis, Angas (non Circe australis, Smith). P.Z.S. Lond., p. 459.

1885. Circe Angasi, Smith. Chall. Zool., vol. xiii., p. 148, pl. 2, f. 4-4e.

Hab.—Bass Strait.

Obs.—A small rose tinted species. Size: Length 6, height 5, diameter 3.5 mm.

Venerupis iridescens, Tate.

1889. Venerupis iridescens, Tate. T.R.S. S.A., vol. x., p. 61, pl. 11, f. 10.

Hab.—Port Albert (Thos. Worcester).

Cyamiomactra nitida, Hedley.

1908. Cyamiomactra nitida, Hedley. P.L.S. N.S.W., vol. xxxiii., p. 477, pl. 9, f. 19, 20.

Hab.—Dredged off Portsea, Port Phillip, also Western Port.

Obs.—A small, smooth, brown shell. Our identification has been confirmed by Mr. Hedley.

Genus **BORNIA,** Philippi, 1836.

Bornia lepida, Hedley.

1906. Bornia lepida, Hedley. P.L.S. N.S.W., vol. xxx., p. 543, pl. 32, f. 22, 23.

Hab.—San Remo, Western Port.

Obs.—Size of type: Height 4 mm., length 6.3 mm. Our shell is much smaller; it "has fine, dense, radiating threads."

Diplodonta sublateralis, E. A. Smith.

1884. Diplodonta sublateralis, E. A. Smith. Alert Zool., p. 104, pl. 7, f. K.

Hab.—Port Albert (T. Worcester); dredged off Point Cook, Port Phillip, 9 fathoms.

Obs.—Size of type: Length 19½, height 18½, diameter 10 mm. The specimens obtained in the last-named locality exceed these dimensions, and have been compared with others from Queensland and Torres Straits.

Diplodonta striata, Hutton.

1850. Lucina novae-zealandiae, Reeve (non Gray). Conch. Icon., vol. vi., pl. 9, f. 14.

1878. Diplodonta striata, Hutton. Jour. de Conch., p. 51.

1880. Diplodonta striata, Hutton. Man. N.Z. Moll., p. 156.

Hab.—Western Port.

Obs.—A globose shell, rudely concentrically striate; whitish, with a light brown epidermis; size of type: Height .4, length .4 inch. Our specimens are much smaller.

Condylocardia crassicosta, Bernard.

1896. Condylocardia crassicosta, Bernard. Etudes Comparatives sur La Coquille des Lamellibranches Condylocardia, p. 2, pl. 6, f. 1.

1908. Condylocardia crassicosta, Verco, T.R.S. S.A., vol. xxxii., p. 360.

1908. Condylocardia crassicosta, May. P.R.S., Tas., p. 54, pl. 6, f. 6.

Hab.—Frankston, Port Phillip (Thos. Worcester); dredged Western Port.

Obs.—Similar to C. pectinata, but the radial ribs are fewer and stronger.

[PROC. ROY. SOC. VICTORIA, 22 (N.S.), PT. I., 1909.]

ART. VI.—*Preliminary Communication on Fifty-three Tasmanian Crania, Forty-two of which are now recorded for the first time.*

BY RICHARD J. A. BERRY, M.D., EDIN. ET MELB., F.R.S. EDIN., F.R.C.S. EDIN.,

AND

A. W. D. ROBERTSON, M.B., CH.B., MELB.,

Government Research Scholar in the University of Melbourne.

[Read 11th March, 1909).

It does not, we feel sure, need any words of ours to emphasise, in a learned Society, the singular importance of the discovery indicated by the title of this paper; suffice it to say that in the whole annals of scientific Tasmanian literature there has never yet been recorded in a single communication such a large number of Tasmanian crania as we have the privilege to lay before the Royal Society of Victoria to-night.

When we reflect that the Tasmanian aboriginal carried with him into the nineteenth century, even into our own times, the primitive culture of palaeolithic man, and into his bodily organism many of the structural peculiarities of Homo Neanderthalensis, we shall perhaps commence to realise the scientific importance of the study of Tasmanian remains.

Of the far-reaching significance of the discovery in the twentieth century of the forty-two undescribed Tasmanian crania which it has been our privilege to find during the last few weeks, two lines of proof will suffice:—

First: The distinguished craniologist, Principal Sir William Turner,(1) in his "The Craniology, Racial Affinities, and Descent of the Aborigines of Tasmania," published so recently as October, 1908, commences his remarks by stating that "the opportunity of collecting additional (Tasmanian) specimens no longer exists."

Second: Turner, in the same memoir, has been at much pains to locate all the Tasmanian crania known to be in existence in the world's museums, and he states that "the crania catalogued in museums as Tasmanian, including those recorded in his own memoir, which have been studied and described by anthropologists, and the measurements of which have been more or less fully recorded, are seventy-nine in number."

These seventy-nine Tasmanian crania are located as follows:—

1.	Various Museums in London - - -	38
2.	Tasmanian Museum, Hobart - - -	12
3	University of Edinburgh, Anatomy Museum -	10
4.	Various Museums in Paris - - - -	9
5.	University of Oxford, Anatomy Museum -	6
6.	University of Cambridge - - - -	2
7.	Museum at Breslau - - - - -	1
8.	Museum at Philadelphia - - - -	1
	Total - -	79

From the two extracts from the memoir just quoted it should, we think, be sufficiently clear that a communication which now brings forward a totally new series of forty-two Tasmanian crania, that is, more than one-half of those previously known to be in existence, must be regarded as of paramount importance.

Passing next to the fifty-three Tasmanian crania with which this communication deals, eleven are common to this paper and to the seventy-nine quoted by Turner as known to be in existence, the remaining forty-two have hitherto been absolutely unknown to the world of science, and of these, eleven were obtained for the first time so recently as February last, and our acknowledgments for the privilege of doing so will be made in due course.

Dealing first with the eleven common to this paper and to Turner's paper, they comprise eleven of the twelve mentioned by him as being in the Tasmanian Museum, Hobart, and which have been described and measured by Harper and Clarke(2) in the "Papers and Proceedings of the Royal Society of Tasmania" for 1897, pages 97 to 110. The explanation of

the deficiency of one is due to the fact that when we were prosecuting our researches on these skulls in January and February, 1909, we discovered that one, number three of Harper and Clarke's memoir, was missing from the museum, and its whereabouts could not be ascertained. As a point of very particular interest, it may be mentioned that this series of eleven comprises the cranium of Truganini or Lalla Rhook, the last of her race.

Of the remaining forty-two, three are those which Harper and Clarke state in their memoir are the crania of half-castes, and three others are those which the same authors rejected *in toto* as not being Tasmanian. We differ from these authors on both points. We have no hesitation whatsoever in stating that all six crania are the crania of pure-blood Tasmanians, and we do so for the following reasons:—

1. These six crania are now, and always have been, catalogued by the Hobart Museum authorities as those of pure-bred Tasmanians. They have therefore always been differentiated from the crania of other races in the possession of the Museum, and there is ample evidence that Hobart Museum Curators, both past and present, have exercised due precautions in the verification of their material.

2. Harper and Clarke do not in their monograph give any sufficient reasons for rejecting these six crania. All they say is that "of this number we rejected at once three skulls as being incorrectly classed, and upon comparing the skulls after measurement, we decided to exclude three others, which in our opinion are those of half-castes. The measurements of these three crania are given in our table, but they are otherwise disregarded."

Attaching, as we did, considerable weight to the work of Harper and Clarke, we were at the outset of our investigations in Hobart prepared to accept their conclusions, but as our research progressed we were forced to the opinion that their data respecting these six crania were erroneous, and we decided to interview Mr. Clarke as to the precise reasons why he and his coadjutor had rejected these crania. Mr. Clarke very kindly came to the Museum and made another examination of the doubtful crania, with the ultimate result that his opinion

seemed to be decidedly weakened, and he stated that so far as he could remember the only reason for rejecting such crania was their rather large cubic capacity, the largest being not more than 1450 c.c

To this we reply that, although unusual, such a large cubic capacity is not unknown amongst Tasmanian aboriginals. Skull No. 7 in Turner's paper, which we have already quoted, has a capacity of 1430 c.c., whilst Klaatsch,(3) speaking of the Australian, says: "Owing to the great variation met with in the capacity of the brain cavity, as shown by all observers, e.g., Turner, Krause, it is not to be wondered at that there are some Australian skulls which are comparable with the average type of higher races, while there are others which even exceed the European average. This does not prove any closer relationship of the larger Australian skulls with those of other races, but demonstrates an independent specialisation taking rise from a common pithecanthropoid root, in conjunction with other races, at a stage when the brain capacity was relatively small."

3. Our third reason—the last and weightiest—for including these six crania as genuine Tasmanian pure bloods, is that every one presents over 90 per cent. of the features so characteristically found in the skull of the Tasmanian aboriginal, and this, we think, should finally set at rest any doubts as to their authenticity.

It will easily be understood that the long isolation of the Tasmanians, the prolonged inbreeding, and the total absence of any extraneous racial crossings, have caused certain morphological characteristics to be absolutely ingrained in the crania. Anyone who has handled Tasmanian crania in large numbers will have forced upon him the striking similarity of these crania, and in a very short space of time will be educated up to the recognition of a Tasmanian skull from amongst any others.

In a preliminary communication such as this we cannot enter into the question of these characteristics. They are fully set forth in almost all recent memoirs on the subject. It will suffice to point out some of the more striking peculiarities.

In *norma verticalis* there is the characteristic keeling along the line of the sutura sagittalis, the well-defined tuber parietale, the obovate outline, the dolichocephaly, the small size of the

post-orbital diameter as compared with the maximum orbital diameter, and which gives to all genuine Tasmanian crania such a striking resemblance to that of the Neanderthal fragment. All these signs were, with the exception of one sign in one skull, present in the doubtful crania.

In *norma lateralis* there is the uniformity in the recession of the forehead which we carefully tested for by the ingenious methods of Schwalbe, the arcus or torus supraorbitalis, the deep depression of the nasion—all of which were easily recognisable in the alleged spurious crania.

In *norma facialis* there is the platyrrhine nasal index, the high position of the nasion relative to the orbits, the rectangular orbital outline and the parabolic palate—all of which were present in the six crania with the exceptions of two features, one from each of two skulls.

Lastly, there were the highly characteristic cranial sutures, the ossa suturarum, and the epipteric bones, the last being present in two of the six—a high percentage—whilst the ossa suturarum were present in no less than three of the doubtful skulls.

In our opinion, therefore, there can no longer be any reasonable doubt that all six skulls rejected by Harper and Clarke are undoubtedly those of absolutely pure-bred Tasmanians, and we have therefore included them in our series, and we do so with every confidence.

We also discovered in the Hobart Museum fragments of three other Tasmanian skulls which are incorporated in our work. This brings the total of Tasmanian crania in the Tasmanian Museum, Hobart, up to twenty, nine of which are now presented to the scientific world for the first time. Had one of Harper and Clarke's original twelve not disappeared, there would, of course, be twenty-one.

Sixteen other Tasmanian skulls were discovered by us in Hobart. Of these, one was in the private possession of Inspector Cook, two were in the possession of Mr. A. J. Taylor, chief librarian of the Carnegie Library, Hobart, and thirteen were in the possession of Dr. E. L. Crowther, eleven of which were first obtained during our visit to Hobart. The whole of these sixteen crania are now dealt with for the first time. Mr.

5a

Taylor was also good enough to present us with a cast of number two of Harper and Clarke's series, numbered 4291, in the Hobart Museum, and this has been deposited in the Anatomy Museum of the University of Melbourne.

Passing up into the interior of Tasmania, nine more, including two fragments, were discovered in the possession of Mr. E. O. Cotton, Kelvedon, and these also are new to scientists.

In the museum at Launceston we dealt with all five skulls in their collection, numbered 1201 to 1205, both inclusive. One more we discovered in the possession of Mr. Leslie Jolly of Launceston, and lastly, we succeeded in discovering two more in the possession of the Devonport Town Board. These eight skulls have not previously been known to scientists.

The extent of our new discovery of Tasmanian crania may therefore be summarised as follows:—

1.	Tasmanian Museum, Hobart - - -	9
2.	Dr. E. L. Crowther, Hobart - - - -	13
3.	Mr. A. J. Taylor, Hobart - - - -	2
4.	Inspector Cook, Hobart - - - -	1
5.	Mr. E. O. Cotton, Kelvedon - - - -	9
6.	Launceston Museum - - - - -	5
7.	Mr. Leslie Jolly, Launceston - - -	1
8.	Devonport Town Board - - - - -	2
	Total - -	42

The details are set forth in Table 2.

Pending the settlement of the question as to where these relics of Palaeolithic Man's sojourn in Tasmania are to be ultimately housed, our problem was how to leave them, in the meantime, in the hands of their lawful owners and at the same time make them available for scientific study in all parts of the world.

This problem we have partially solved by taking accurate dioptrographic tracings of every skull in four normae, namely, norma verticalis, norma lateralis, norma facialis, and norma occipitalis, all of which are recorded, life size, by means of Professor Martin's ingenious instrument. We have therefore taken no less than 212 tracings of these Tasmanian crania,

168 of which comprise fresh material. If this work is to be attended with the ultimate results that its importance demands, it is imperative that these 212 drawings be published in their original form, and that as soon as possible.* This for four reasons: —

1. If the crania be left in private ownership, as the majority of them are at the present moment, they will inevitably, on the demise of their present proprietors, be either dispersed or lost, and there will be no traces of them left.

2. Publication in life size will render the material available to craniologists all the world over.

3. As craniological methods have been revolutionised during the last few years by the discoveries of Pithecanthropus, Neanderthal, Spy, Canstatt, Egisheim, etc., and also by the new investigational methods of Schwalbe, Klaatsch, the Sarasins and others, it is not improbable that another fifty years may elicit still more startling discoveries with the introduction of still more revolutionary craniological methods, in which case these Tasmanian crania may require fresh investigation, which cannot well be undertaken if the present-day material be not imperishably recorded.

It is not too much to say, in view of these possibilities and suggestions, that all known existing Tasmanian crania, whether in Europe, America or Australasia, ought to be similarly recorded, and thus made available for study in all parts of the world, and for all time.

4. A fourth and last reason for publication in life size is the fact that all measurements can be made upon the tracings.

Concerning the question of measurements, we measured all the crania that passed through our hands. Craniologists differ very markedly as to what measurements ought or ought not to be taken, with the consequent result that thousands of useless figures have been, at one time or another, recorded. Sir William Turner has very properly set his face against this useless recording of redundant figures, but in view of the fact that the British Association for the Advancement of Science,(4) and, further, a European International Commission,(5) have

* The Government of Victoria has generously undertaken the cost of publication of this work.

recently dealt with this question, and laid down the measurements which should be taken, we have adopted their suggestions and taken our measurements accordingly.

The tracings which we have recorded will suffice for almost all such measurements to be recorded upon them, and for all angular work upon the median sagittal sections, and therefore for almost all of the exquisite methods recently introduced by the distinguished Schwalbe. They will not, however, serve for the horizontal and coronal curves introduced by the Sarasins in their investigation on the Veddah,(6) and more recently adopted with so much success by Klaatsch in his investigation of the Australian aboriginal skull.(3) Such tracings require to be taken by a special instrument termed the diagraph. This instrument in its improved form was not on the market when the first order for anthropological instruments was despatched to Europe from the Anatomy Department of this University, and although it was subsequently ordered it was not to hand at the time of the investigation. We were, therefore, unable to take these curvilinear outlines.

One of the earliest purposes to which it is proposed to utilise the present material is the determination of the relationship of the Tasmanian to the anthropoids and primitive man on the one hand, and to the Australian aboriginal on the other hand. Schwalbe's fine study of the Pithecanthropus erectus(7) may serve as a basis for the former purpose, and Klaatsch's recent work(3) for the latter, though it must be remembered that innumerable authors have contributed to both subjects.

As regards the relationship of the Tasmanian to the Australian aboriginal, one of us has already made a communication to this Society.(9) Since the date of that paper, Klaatsch(3) has enunciated the view that both the Australian and Tasmanian aboriginal peoples have sprung from a common root, of which the Tasmanian is the type, and which has become very distinct through local isolation. He utterly scouts the idea of the Australian being a mixed race, though he admits an occasional intermixture with Papuan blood on the north-east coast of Australia, and also admits the possibility of the occurrence of two Australian types, as originally put forward by Topinard. Klaatsch explains the occurrence of two such types, not by a

racial admixture, but by local isolation on a vast continent due to defective communication. "In this way," says Klaatsch, "there has been time and room enough to effect local specialisations in the primitive unitary type which must be accepted as the common root from whence sprung all the Australian and Tasmanian people."

This view is, of course, in direct opposition to Ling Roth,[10] who supported the opinion that the curly-haired Tasmanian was the primitive inhabitant of Australia, and was subsequently displaced by the much straighter-haired Australian Aboriginal.

To those members of this Society who heard Berry's[9] paper of 1907, it is not without interest to note that Turner,[1] the latest contributor to this subject, concludes his statement with the following words:—

"The evidence seems to be in favour of the descent of the Tasmanians from a primitive Negrito stock, which migrated across Australia, rather than by the route of the Melanesian Oceanic islands lying to the north and east of the Australian continent."

This preliminary communication, brief though it be, must conclude with a lengthy expression of thanks. It need hardly be said that such a large collection of undescribed material could not possibly have been obtained without much kind assistance. We desire, therefore, to express our most grateful thanks to Dr. J. S. C. Elkington, the permanent head of the Tasmanian Public Health Department, who prepared the way for us, and who at all times rendered us the most courteous assistance; to the Trustees of the Hobart Museum for the use of their invaluable material; to Mr. Hall, the Curator of the Museum; to the President and Council of the Royal Society of Tasmania for the use of their rooms and library; to the Trustees of the Launceston Museum and its Curator, Mr. Scott; to the Devonport Town Board and Mr. B. C. Green, the Secretary, for so kindly forwarding their material for use in Launceston; to all the private owners of crania whose names have already been mentioned; to Drs. E. L. Crowther and A. H. Clarke for much kind assistance; and lastly to Messrs. W. L. Crowther and W. J. Clark, who did all in their power to make our visit to Tasmania a successful one. A word is also due to Mr. Arnold,

the caretaker of the Hobart Museum, for his uniform kindness and courtesy.

We can only conclude with the hope that this unexpected discovery of material, said by the European savants to be now beyond all hope of redemption, may stimulate us to further efforts in the same field.

TABLE I.

NUMBER, LOCATION AND SEX OF EXTANT TASMANIAN CRANIA, DESCRIBED PRIOR TO THE BERRY AND ROBERTSON DISCOVERY.

	Male.	Female.	Youthful.	Sex not Stated.	Total
1. Royal College of Surgeons. England. Owen, Flower	9	7	3	1	20
2. Royal College of Surgeons, England. Barnard Davis Collection	9	6			15
3. British Museum of Natural History, South Kensington, London	1				1
4. Museum of Army Medical Department, Millbank, London	1		1		2
5. Museums in Paris. Topinard, De Quatrefages and Hamy	5	3	1		9
6. Breslau (fragment only)	1				1
7. University of Oxford. Anatomy Museum. Turner	2	4			6
8. Tasmanian Museum, Hobart. Harper and Clarke	6	6			12
9. University of Cambridge (fragments). Duckworth	2				2
10. Philadelphia				1	1
11. University of Edinburgh. Anatomy Museum. Turner	8	1	1		10
	44	27	6	2	79
Subtract one lost from Hobart					1
					78

TABLE II.

NUMBER, LOCATION AND SEX OF THE 42 TASMANIAN CRANIA DISCOVERED BY BERRY AND ROBERTSON.

	Male.	Female.	Youthful.	Sex not Stated.	Total.
Tasmanian Museum, Hobart. Complete skulls. Nos. 4320 M., 4297 M., 4290 F., 4295 F., 4296 M., 4303 F., 1572 F. - - - -	3	4			7
Tasmanian Museum, Hobart. Fragments. Fronto-occipital fragment, F. Frontal fragment, M. - - - - - - -	1	1			2
Museum, Launceston. Nos. 1201 M., 1202 F., 1203 M., 1204 M., 1205 M. - - - -	4	1			5
Devonport. Nos. 1 M., 2 F. - - - - -	1	1			2
Mr. Leslie Jolly. Launceston - - - -	1				1
Inspector Cook. Hobart - - - - -	1				1
Mr. A. J. Taylor. Specimen with face attached M. Specimen with face detached F. - -	1	1			2
Dr. E. L. Crowther. Hobart - - - - -	8	3	1	1	13
Mr. E. O. Cotton. Kelvedon - - - - -	7			2	9
Totals of Berry and Robertson Collection	27	11	1	3	42
Carried forward from Table I. - -	43*	27	6	2	78*
Totals of Tasmanian Crania - - -	70	38	7	5	120

*After subtraction of missing skull from Tasmania.

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10. Roth, H. Ling,—"The Aborigines of Tasmania." 2nd edition. Halifax, 1899.

[PROC. ROY. SOC. VICTORIA, 22 (N.S.), PT. I., 1909.]

ART. VII.—*Contributions to our knowledge of Australian Earthworms.*

THE BLOOD VESSELS—PART I.

BY GWYNNETH BUCHANAN, B.SC.,

Government Research Scholar in the Melbourne University.

(Plates XIV.-XVII.).

[Read 8th July].

Mr. J. J. Fletcher and Professor Spencer, in their general descriptions of Australian earthworms, have dealt briefly with certain of the main features of the arrangement of the blood vessels. In connection with an extended series of investigations into the structure of Australian earthworms, which is now being carried on in the Biological Laboratory of the Melbourne University, Professor Spencer has suggested that I should undertake the portion concerned with the blood vessels. The present communication forms the first instalment of this work, and I am indebted to Professor Spencer for the use of specimens from his collection, as well as for much valuable advice during the progress of the work, further instalments of which I hope to publish shortly.

The species examined belong for the most part to the Genera Megascolides, Megascolex, Perichaeta, Diporochaeta and Cryptodrilus, and I have to thank Miss Bage, M.Sc., for the use and explanation of her lists of the names and synonyms of the specimens in the collection. I have only given descriptions of dissections in most cases, as, for the present paper, I have not examined microscopically more than three worms—viz., *Perichaeta fielderi*, *Fletcherodrilus unicus* and *Cryptodrilus gippslandicus*. Of the first of these, serial sections were taken at the anterior and tail end; of the latter two, only at the anterior end of the region of the hearts. These two were

specially selected on account of the double dorsal vessel in *C. gippslandicus*, and of the large vessels in *F. unicus*, which made the structure of valves, etc., easier to make out in detail.

Of course it is very hard, even with a dissecting microscope, to make out some of the very fine connections (especially without the aid of living specimens, which might be injected), and a later examination which I hope soon to undertake with the aid of serial sections, may disclose junctions between vessels not noticeable before, or their absence, where they were thought to exist—for instance, in the relation between the dorsal and ventral vessel in the first and last segments; and the method of ending of the supra and subintestinal at the anterior end. Bourne (11) in his paper on *Megascolex coeruleus* describes the dorsal vessel as ending abruptly at the posterior end, and breaking up at the anterior, while he states that Jacquet figures peripharyngeal commissures between the dorsal and ventral vessels, sometimes as very fine threads, so that the presence or absence of this connection is apparently not a constant feature.

Nomenclature of Vessels.

The accompanying diagrams (Plate XVI., Figs. A, B, C, D) will serve to indicate the nomenclature of the blood vessels that I propose to employ during the course of this investigation.

In none of the worms examined have I found a subneural vessel. Bourne (11) says this is absent in all the simpler, and many of the more complex forms, e.g., many, if not all, the Perichaetidae, Pontodrilus and Microchaeta. He uses the term "ventral" for the subintestinal which, he says, is constant in all Oligochaetes, evidently meaning the main ventral vessel of Australian forms, and not that which I have called subintestinal. This latter, together with my lateral, forms what he calls the Intestino-tegumentary vessels of Perrier (Rech. pour servir àl' hist. des Lombriciens terrestres," Nouv. Arch. du Mus. d'Hist. Nat. de Paris, 1872), or his latero-longitudinal vessels, which, he says, are exaggerated anterior representatives of a series of similar vessels, which occur in every segment, and to which whole series he gives the name intestino-tegumentary. He defines Hearts as those vessels which are

rhythmically contractile, circularly disposed, and which may be (1) all connected with the dorsal, or (2) some only and some with the supra-intestinal, or (3) some with the dorsal vessel only and some with both. He calls the first lateral; those which only connect with the Supra-intestinal, Intestinal; and those which connect with both Latero-intestinal. I have kept the word Heart for only those vessels which arise from the Supra-intestinal, and pass to the ventral, with or without branches from the dorsal (except in the case of *D. davallia*, where sections would probably show the connections between dorsal and supra-intestinal), and have called those passing from the dorsal to the ventral anterior to these, anterior commissural vessels. These Benham (5) also calls "lateral hearts." My supra-intestinal evidently corresponds to Bourne's dorso-intestinal, while those vessels at the extreme anterior end, which break up without joining the ventral, belong to his dorso-tegumentary system. In the post-cephalic region (Bourne 11, note page 73) the branches may be posterior commissural, or dorso-intestinal, or tegumentary, the chief difference being, in those specimens I have examined, that the anterior one arise at the posterior end of the segment, and the posterior from the middle.

The generic names employed are those given by Beddard in his "Monograph of the order Oligochaeta."

1.—Megascolides gippslandicus, Spencer.

Cryptodrilus gippslandicus, Spencer. P.R.S. Vict., 1892.

Plate XIV., Figs. 1, 1a, and Plate XVII., Fig. 20.

Dissection.—The specimen examined was broken for some distance behind segment 14. There is a *double dorsal vessel* becoming single at the tail end, the two halves alternately joining at the septa, and becoming divided on passing through them in the anterior region, and running forward thus to the front of segment 6, where they finally unite to form a single vessel, which breaks up in the first segment.

In segments 10, 11, and 12, there are no *commissural* vessels arising from the dorsal, but behind this, one main one arises on each side about the middle of the segment, and runs down to join the ventral one, sending branches to the alimentary canal on its way. In segments 9, 8, 7, 6 and 5 there are commissural vessels arising from the dorsal. That in segment 4 does not reach the ventral, but runs back as far as segment 9 as the *lateral*. In segments 10, 11 and 12 this receives a branch from the plexus on the alimentary canal, forming a *sub-intestinal* on each side.

The *ventral vessel* is single, and runs forward to the first segment, breaking up there. In segments 6, 7, 8, and 9 the vessels connecting it with the dorsal give out marked branches to the ventral body-wall before joining it. The *supra-intestinal vessel* arises from the dorsal posteriorly in segment 12, and runs forward to the front of 8. It gives off three pairs of *hearts* in 10, 11 and 12, and in these segments also are marked branches to the alimentary canal arising from the supra-intestinal and running round to join the sub-intestinal. Professor Spencer (15) describes six pairs of hearts in segments 6-12. His anterior ones are evidently in this as in other cases, those I have called anterior commissural.

Sections.—The blood supply in one segment in the region of the hearts, as reconstructed from serial sections, is seen to be complicated. At each mesentery the double dorsal vessel unites to form a single one. At the point of junction a valve (Fig. 20 v.) is formed, and the vessels there divide again. In the hinder part of each segment the supra-intestinal unites with the vessel formed by the union of the two hearts of the segment, at which point a valve is placed; and the supra-intestinal runs forward to the next segment, giving off marked vessels to the alimentary canal, on whose walls is formed a close plexus.

The ventral vessel in each segment receives the heart, the junction being guarded by a valve, and just before the point of union a branch is given off to the ventral body wall and nephridia (Fig. 20, Af. Ne)—the ventro-tegumentary of Bourne. A short distance up, the heart, which is here much smaller in section than on the dorsal surface, gives off from a valved

opening a branch to the sub-intestinal vessel (Fig. 20). From the alimentary canal a vessel passes on each side uniting in the middle line (Fig. 20, M.V.), and then passing to the sub-intestinal as a single vessel on each side. Close to this opens a branch from the ventral body wall and nephridia (Fig. 20 Ef. Ne). Since that to the excretory organs is given off from the heart just before the latter joins the ventral vessel, the blood is propelled to them with the full force of the contraction of the heart. This agrees with Bourne's (11) description of the course of the blood supply to the large nephridia, and with Benham's (6) of that in Lumbricus, though these two authors are not at one as to the course of the blood through these vessels.

2.—Megascolex goonmurk, Spencer.

Perichaeta goonmurk, Spencer. P.R.S. Vict., 1892.

Plate XIV., Figs. 2, 2a.

Dissection.—The dorsal vessel is double (Fig. 2a, D.D.V.) along the greater part of its length, but thirty-one segments from the posterior end it becomes single, and at each mesentery the two halves unite as far forward as the front of segment 10, then remain double till the front of 5, where they unite to divide again, joining at the front end, and giving off a *commissural vessel* on each side to join the *ventral*, which is single along the whole length of the body. It is united with the dorsal by a pair of commissural vessels in each segment at the posterior end, and this arrangement is continued forward as far as segment 13. From the posterior part of segment 12 the dorsal gives off a supra-intestinal which runs forward to the front of 9, giving off in segments 10, 11 and 12 a pair of *hearts* posteriorly in each segment, which run round and join the ventral vessel. I have been unable to find the double supra-intestinal vessel described by Professor Spencer in this form (13). From 9-5 the dorsal gives off in the posterior part of each segment a pair of commissural vessels, and in 4 one which, after running a short distance, divides into two, one passing forward to the cerebral ganglion to form part of the intestine-

tegumentary plexus of Bourne; and one back as the *lateral* at first, and then as the *sub-intestinal* one each side, and ending on the posterior septum of 13. This vessel receives, in segments 9, 10, 11 and 12, branches from the alimentary canal which derive their blood from the supra-intestinal, and in segments 5, 6, 7 and 8, it gives off branches to the ventral body wall whose origins in some cases are marked by swellings (Fig. 2, Sw.), which probably are contractile, and serve to propel the blood. Bourne (11) has also noted such muscular swellings on his "anterior lateral hearts."

3.—Diporochaeta davallia, Spencer. P.R.S. Vict., 1900.

Plate XIV., Fig. 3.

Dissection.—The dorsal vessel is single, swollen in segments 13-15, and running forward to the first segment, where it divides into two, and joins the ventral one. At the posterior end of the body the dorsal and ventral are connected by a *commissural vessel* on each side, and this arrangement is continued forward, in segment 15 there being two such connections in the specimen examined. From the hinder part of segment 13 the dorsal gives off a *supra-intestinal* running forward to the front of 10, and, in segments 10, 11 and 12 hearts arise from the dorsal running round to the ventral vessel, one pair in the hinder part of each segment. From 9-4 the dorsal gives off a pair of commissural vessels posteriorly in each segment, and in 4 this beanch gives rise to a *lateral* which divides into two, one half running forward and one back; the latter giving in segments 4-9 marked branches to the ventral body wall, and uniting in the anterior part of segment 10 with its fellow of the opposite side to form a *single sub-intestinal vessel* which receives branches from the alimentary canal in segments 10-12, deriving their blood from the supra-intestinal, which also gives a vessel on each side to the ventral in segment 13. The branch from the dorsal in segment 3 does not reach the ventral vessel, but the ventral becomes much branched in this region, and is single for the whole length of the body.

4.—**Megascolex tenax**, Fletcher.

Perichaeta tenax, Fletcher. P. Linn. Soc., N.S.W., vol. ii., 1887.

Plate XIV., Fig. 4.

Dissection.—The dorsal vessel is single, swollen in segments 10-15, and joining the ventral by a *commissural* branch on each side, supplying the alimentary canal on the way, at the posterior end of the body. The dorsal and ventral vessels are thus connected as far forward as segment 14, there being no such vessel in segment 13. From the hinder part of each segment, from 9-5, a pair of commissurals arises, and in 9, 8, 7, and 6 each gives off marked branches to the ventral body wall (Br.W.), in some cases from a distinctly swollen patch, which probably has a propelling function (cf. similar structures in *M. goonmurk*). A well-marked vessel arises from the dorsal on each side in the posterior part of segment 4, but does not reach the ventral, dividing instead into two, one of which runs forward to segment 1, in which dorsal and ventral also break up; and the other passes as a *lateral* through segments 5, 6, 7, 8 and 9, and as a *sub-intestinal* through 10, 11, 12 and 13, ending in this last. Small vessels, only running a short distance down and then breaking up, arise from the dorsal in segments 2 and 3, forming the anterior network of the dorso-tegumentary of Bourne. A *supra-intestinal* vessel arises from the dorsal in the posterior part of segment 13, and runs forward to the front of 10. From this branches are given off on each side, supplying the alimentary canal, in segments 10, 11, 12 and 13, and joining the sub-intestinal on each side on the ventral surface. In 10, 11 and 12 *hearts* also arise from the supra-intestinal, one pair posteriorly in each segment, and pass to the ventral vessel—the anterior pair being not very conspicuous in the specimen examined.

The ventral vessel is single, running the whole length of the body, and joining the dorsal at the anterior end by a very fine branch.

5.—Perichaeta obscura, Spencer. P.R.S. Vict., 1892.
Diporochaeta obscura, Spencer.

Plate XIV., Fig. 5.

Dissection.—The dorsal vessel is single and swollen in segments 13-17, running the whole length of the body, and breaking up in segment 1, but connected with the ventral by a commissural vessel on each side at the posterior end of the body. It gives off from the posterior part of segment 12 a *supra-intestinal,* and from this point also a heart arises on each side. The supra-intestinal gives off a pair of hearts in segments 10 and 11, in the posterior part of the segment, and also, in 9, 10, 11 and 12, a vessel to the alimentary canal, and joins the dorsal at the front of segment 9. From 9-4 the dorsal gives off posteriorly in each segment a pair of commissurals, but in 3 this vessel does not seem to pass to the ventral surface, and in 4 it gives off on each side a *lateral* which runs back and forms the *sub-intestinal* ending on the posterior septum of 13, and receiving in segments 9, 10, 11 and 12 branches from the alimentary canal derived from the supra-intestinal.

The ventral vessel is single along its whole length, and breaks up in segment 1.

6.—Perichaeta manni, Spencer. P.R.S. Vict., 1900.
Diporochaeta manni, Spencer.

Plate XIV., Fig. 6.

Dissection.—Dorsal vessel single, breaking up in segment 1 and swollen in 13-17. Connected with the ventral by a *commissural vessel* on each side in 13, and giving off in this segment a *supra-intestinal,* running forward to the front of 8. In segments 10, 11 and 12 this gives rise to a pair of hearts posteriorly in each segment, and also a branch to the alimentary canal. From 9-5 the dorsal gives off commissurals in the hinder part of each segment, that in 6 sends a branch forward to 5 and back to 9, as the *lateral* to be continued in segments 10, 11 and 12, as the *sub-intestinal.* If vessels come off from the dorsal in front of 4 they are too small to trace round. The *ventral* is single, and runs forward to break up in segment 1.

7.—**Perichaeta macquariensis**, Fletcher. Proc. Linn. Soc. N.S.W., vol. iv., 1889.

Megascolex macquariensis, Fletcher.

Plate XV., Fig. 7.

Dissection.—Dorsal vessel single and swollen in segments 10-18, running forward to break up in the first segment.

The ventral also is single, and breaks up in the first segment, giving off marked branches to the ventral body wall in segments 5, 6, 7, 8 and 9, and receiving in these segments a *commissural* vessel from the dorsal. Commissurals also arise from the dorsal from segment 13 backwards. That in 4 does not reach the ventral, but divides into two, one running forward to segment 1, and the other back as the *lateral* in 5-9, and as the *sub-intestinal* in 10, 11 and 12 in the last of which it ends. In these last three it gives off vessels ending on the posterior septum of the segment. Bourne (11) also remarks that in *M. coeruleus* the anterior of his lateral hearts do not reach the ventral vessel, but give off branches to connect with the intestino-tegumentary system.

A supra-intestinal arises from the dorsal vessel posteriorly in segment 12, and runs forward to the front of 10, giving off in 10, 11 and 12, in the hinder part of the segment, a pair of *hearts*, which pass to the ventral vessel, and also from this vessel branches arise which supply the alimentary canal and join the sub-intestinal.

8.—**Perichaeta valida**, Fletcher.

Plate XV., Fig. 8.

Dissection.—Single dorsal vessel, swollen in segments 13-16, less so in 12-9. From 13 backwards it gives off a *commissural* vessel in each segment, supplying the alimentary canal on the way, and this arrangement is continued to segment 13 in which there is no connection between the dorsal and ventral. These latter both run forward, breaking up and apparently joining in segment 1, and the dorsal gives off a *supra-intestinal* in the hinder part of 13, which runs forward to the front of 7. Commissural vessels arise from the dorsal in 9-4, and reach

the ventral, but that in 3 turns back and runs to the posterior mesentery of 13 as the *lateral*, as far as 9, and afterwards as *sub-intestinal*, giving off in 4 a branch running forward to segment 1. There is a very strongly marked development of blood vessels on the wall of the alimentary canal in segment 5, and in 7, 8 and 9 a branch arises from the supra-intestinal and breaks up on the wall of the oesophagus. In segments 10, 11 and 12 this vessel joins the sub-intestinal. *The hearts* are 3 pairs, arising from the supra-intestinal posteriorly in segments 10, 11 and 12, and run round to join the *ventral*, which passes along the whole length of the body, breaking up in segment 1.

9.—Diporachaeta richardi, Spencer.

Perichaeta richardi, Spencer. P.R.S. Vict., 1900.

Plate XV., Fig. 9.

Dissection.—Dorsal vessel single, swollen in 13-15, and breaking up in segment 1. At the posterior end it seems to be connected as in other forms with the ventral, but the latter is here very small. Professor Spencer (14) describes the dorsal as breaking up in the second or third segment. The dorsal gives off a supra-intestinal posteriorly in segment 12, which runs forward to the front of 10, giving rise, in the hinder parts of segments 10, 11 and 12, to pairs of hearts to join the ventral, and a vessel on each side to the alimentary canal. In segments 5, 6, 7, 8 and 9, the dorsal gives off *commissurals*, that in 5 sending a branch back as the *lateral*, at first and, later, as the *sub-intestinal* on each side which receives branches in 10, 11 and 12 from the alimentary canal. If the dorsal gives off any vessels in front of 5, they must be small, and break up soon. The *ventral* runs forward to segment 5, where it breaks up.

13.—Fletcherodrilus unicus, Fletcher.

Cryptodrilus fasciatus, Fletcher, Proc. Linn. Soc. N.S.W., 1889.

Plate XV., Fig. 10, and Plate XVII., Figs. 21, 22, 23.

Dissection.—Single dorsal vessel, very much swollen from 10-16, and running forward to divide into two in the posterior

part of segment 3, and to break up in segment 1. At the extreme posterior end *commissural* vessels, supplying the alimentary canal on the way, arise, one pair in each segment, but seven segments from the end and forward for some distance there are two of these vessels to the segment, probably one belonging to the dorso-intestinal or tegumentary system of Bourne (11). The *ventral* runs forward and ends in the first segment. There is no commissural between it and the dorsal vessel in 13, but behind this segment one main one passes round in each segment, supplying the alimentary canal on the way.

From segments 9-5 a similar vessel is found, arising as usual in the case of the anterior commissurals in the hinder part of the segment. In 4 this vessel does not reach the ventral one, but half way round it divides into three. One branch runs forward to break up definitely in segment 1; one back to end on the posterior mesentery of 13, forming the *lateral* in 5, 6, 7, on each side, and in 8, 9, 10, 11, 12 and 13 the *sub-intestinal* receiving in each of these segments vessels from the alimentary canal wall. The third branch from the commissural in 4 unites with its fellow of the opposite side in segment 4 to form a short transverse vessel under the alimentary canal.

The *supra-intestinal* arises from the dorsal in the posterior part of 13, and runs forward to the front of 8. Three pairs of *hearts* are present, one in each of segments 10, 11 and 12, arising from the supra-intestinal posteriorly in each, and receiving a small branch from the dorsal close to their point of origin.

Sections.—In the region of the hearts, the blood supply is seen to be fairly simple. In the hinder part of each segment, on either side, the dorsal vessel sends a branch, whose opening is guarded by a valve, to join the supra-intestinal, which opens by a valve (Figs. 21, 22v, 23v) into the heart (Figs. 22 and 23Ht.); and then runs on, giving various branches to the alimentary canal, forming a plexus on its walls (Figs. 22 and 23 Pl.). The heart passes to the ventral surface, and opens by a valve (v.) into the ventral vessel, which is a single tube. The blood from the plexus (Pl.) round the alimentary canal is collected into the sub-intestinal vessel (Sub. I.V.), which is double to the end of segment 13.

The nephridia are supplied by vessels opening directly from the hearts (Fig. 23 Af. Ne.), while the blood is brought back in small vessels opening into the sub-intestinal (Ef. Ne.). Benham (6), in describing the vascular supply to the nephridium in Lumbricus, says the course of the blood is along the commissural, which receives blood from the nephridia and body wall, to the dorsal, which then supplies the alimentary canal. Bourne (11) says blood passes from the nephridia to the sub-intestinal, and from the alimentary canal plexus to the dorsal vessel, in this agreeing with Vejdovsky. The valves (Figs. 21, 22a, 22b) are shown in section to be membranous, almost funnel shaped structures, stretching across the vessel, with a circular opening in the middle. The most marked sets are those in the dorsal vessel at each mesentery, which are attached to a well-marked muscular thickening on the wall; and those leading from the supra-intestinal to the hearts, which, however, do not seem to be connected with any such thickenings.

The branch from the dorsal vessel to the heart is also guarded by a similar, though very small, valve, and the whole structure has very little the appearance of a functional vessel. In the case of the dorsal vessel the action of the valve is clearly that of guiding the blood forwards and preventing it from flowing backwards. In the event of the blood attempting to flow backwards, it is evident that the pressure of the fluid on the wall of the funnel would close the opening in the latter. The valves leading towards the hearts are so small that it is difficult to determine their exact structure and relationships. The valves guarding the entrance of the supra-intestinal into the hearts have the convex face of the funnel facing into the heart. Pressure of blood on the heart—that is, the convex side—would close the small opening in the funnel.

11.—Megascolex fielderi, Spencer.

Perichaeta fielderi, Spencer, P.R.S. Vict., 1892.

Plate XV., Fig 11, and Plate XVII., Fig. 24.

Dissection.—The *single dorsal vessel* is much swollen in segments 16-9, and runs forward to break up in the first segment. At the posterior part there is a commissural vessel supplying

the alimentary canal on the way. This arrangement apparently persists in the last segment, and is continued forward in each to the region of the swellings in the dorsal vessel.

In segments 9, 8, 7, 6, 5 and 4, a commissural arises from the back of the segment on each side. In segment 5 this vessel divides into two after a short distance, one half running forward to break up in the salivary gland; and one passing back as the *lateral*, forming a double *sub-intestinal* in 10, 11, 12 and 13, and ending in 13. In these segments it receives branches from the plexus on the alimentary canal, derived from the *supra-intestinal*, which rises from the dorsal in the hinder part of the segment 14, and runs forward to the front of segment 8, receiving a small branch from the dorsal in 10, 11, 12 and 13 on each side, and giving off from the point of junction of this in each of these segments a pair of *hearts* to the ventral vessel. The most anterior of these is smaller than the others, and there seems to be a tendency to a more than ordinary development of hearts in this species, as, in addition to the 4 pairs commonly met with in *M. fielderi*, a single heart was found in one specimen in segment 14 on the left side (cf. Beddard, 1). In 14 there seems to be no commissural, but a vessel arises from the supra-intestinal apparently ending on the alimentary canal wall.

The *ventral vessel* is single, and runs forward to break up segment 1.

Sections.—The blood supply in the heart region is fairly simple. In the interior part of each segment the dorsal vessel gives off a pair of small branches with valvular openings (Fig. 24, V.), to the supra-intestinal, and from, or close to, the junction of those two the supra-intestinal gives off a pair of hearts, their openings being guarded by valves. The hearts join the ventral vessel on its under surface by a valvular opening. The supra-intestinal gives off a branch to the alimentary canal, forming a thick plexus on its walls (Pl.), from which a main vessel passes on each side to the sub-intestinal. In the region of the hearts the nephridia are micro-nephric, and the origin of their blood supply is indefinite, but is probably from the ventral vessel or its ventro-tegumentary branches. At the hinder end, where the excretory organs are meganephric, they

seem to derive their blood from the main commissural vessel soon after its origin, branches passing to the nephridia on one side and alimentary canal on the other, all the way down the segment (compare *F. unicus*, Fig. 23, in which the nephridial vessel arises from the heart). The vessel from the alimentary canal on the ventral side is small and median, and opens into the ventral.

12.—**Megascolex dorsalis**, Fletcher.

Perichaeta dorsalis, Fletcher, Proc. Linn. Soc. N.S.W., Vol. II., 1887.

Plate XV., Fig. 12.

Dissection.—The *dorsal vessel* is single, swollen in segments 14-17, joining the central by a single *commissural* vessel on each side, at the posterior part of the body, in each segment, and dividing at the anterior end into a very fine branch on either side, running round to the ventral, which is here small. Forward from the tail end a pair of main commissurals are given off in each segment, but posteriorly in segment 13 a *supra-intestinal* arises from the dorsal, giving off a pair of hearts at its point of origin, and runs forward to break up on the alimentary canal in segment 8. In the hinder part of segments 10, 11 and 12 also, a pair of hearts arise, making four pairs in all, and each receives a small branch from the dorsal close to its origin. In 9, 10, 11, 12 and 13 the supra-intestinal gives a branch to the alimentary canal. In segments 9-6 a pair of commissural vessels rise from the dorsal, posteriorly in each segment, and pass to the ventral, giving a branch to the alimentary canal (B.A.), and ventral body wall (Br.W.) on the way. In segment 5 the commissural gives off a lateral one each side before joining the ventral, and this lateral divides into three, one branch running forward to break up, one passing under the alimentary canal to join its fellow of the opposite side, and one back as the lateral, and later as the *sub-intestinal*, which gives a branch to the septum (B.S.) in each segment from 6-12, and ending posteriorly in segment 13. The sub-intestinal receives branches from the alimentary canal, derived from the supra-intestinal in segments 9, 10, 11, 12 and 13.

The *ventral* vessel is single, occurring the whole length of the body.

13.—Digaster excavata, Fletcher.

Perissogaster excavata, Fletcher. Proc. Linn. Soc., N.S.W., 1888.

Plate XV., Fig. 13.

Dissection.—*Dorsal* vessel single, swollen in segments 13-15, less so in 12-10, and running forward to segment 1, where it divides into two, one branch running round to each side to join the ventral. From 19 backwards the dorsal sends a *commissural* to join the ventral in each segment, supplying the alimentary canal on the way, but from 18-14 there are two of these branches to the segment. In segment 13 the dorsal is not connected with the ventral at all, but gives off at the posterior mesentery a *supra-intestinal*, which runs forward to the end, apparently blindly, in the front of 8. Posteriorly in segments 10, 11 and 12 a pair of *hearts* arise, each having a double origin—from the dorsal and supra-intestinal vessels—and runs round to the ventral. In segments 9-4 the dorsal gives off a commissural on each side in the under part of the segment, passing to the ventral, and giving a branch to the ventral body wall (Br.W.), and back septum (B.S.) in 9-5, and in 8-5 one to the alimentary canal (B.A.). That in segment 4 gives rise to the *lateral*, which runs back as the *sub-intestinal*, and also, apparently, forward to break up in the salivary gland, but both this and its junction with the commissural vessel in segment 4 are indistinct, owing to the large development of this gland. The subintestinal remains distinct on each side, and runs back to segment 16, giving branches to the posterior septa of segments 13 and 14 (B.S.). It receives in 9, 10, 11, 12 and 13 vessels from the alimentary canal derived from the supra-intestinal. The *ventral* is single along its whole length, breaking up in segment 1, and receiving, as described, a branch from the dorsal in this segment.

14.—**Megascolex coxii**, Fletcher.

Perichaeta coxii, Fletcher. Proc. Linn. Soc. N.S.W., 1888.

Plate XV., Fig. 14.

Dissection.—Dorsal vessel single, swollen in segments 10-15, though not much so. It runs the whole length of the body, and in segment 1 divides into two, passing round on each side to join the ventral vessel. The dorsal and ventral arc also apparently connected as usual at the posterior end, the dorsal giving off a pair of commissurals to join the ventral in each segment, as far forward as the region of the *hearts*. In 14 and 15 these branches are two in number at their origin from the dorsal, though it is not clear if both reach the ventral. This latter becomes double in segment 14 in one specimen examined, but this is probably only an individual variation, as it was not noticed in the other, nor in any other species. In the hinder part of segment 13 the dorsal gives off a pair of *hearts* to the ventral, joining it on the under side, and this arrangement is continued forward to 10, the only other worms in which four pairs of hearts were observed being *P. fielderi*, *P. dorsalis* and *C. grandis* (see Beddard, 1). That in segment 13 may be said to give rise to the *supra-intestinal*, which runs forward to the front of 7, or, the hearts may be taken as having a double origin, but the supra-intestinal does not appear to run back beyond the first pair, seeming rather to arise from the dorsal through them. From the back of 9-4 the dorsal gives off in each segment the usual *commissural vessels*, which send branches to the ventral body-wall (B.W.) in 9-6. In segment 4 the commissural gives off close to its origin a *median vessel*, which runs back to break up in a large plexus over the alimentary canal in segment 5. The whole of the anterior part of the digestive tract and the salivary glands are particularly well supplied with blood in this form, especially in segments 4, 5 and 6. In segment 3 a vessel arises from the dorsal, but appears not to reach the ventral, while from the commissural in segment 4 arises, on each side, as well as the median, a *lateral* vessel, which sends branches forwards to the salivary gland, and one backwards, forming later on the *sub-intestinal.*

In segment 6 there is an unusually large development of branches from the lateral, one supplying the alimentary canal in this segment, and two running forward to do so in the more anterior ones; while one large vessel passes to the ventral surface. In segments 6-9 the lateral gives branches to the posterior septum (B.S.) in each segment, and in 7-13 it receives branches from the alimentary canal, derived from the supra-intestinal in 13-8, and probably in 7 also, though here the latter vessel is small, and the origin of the branch to the alimentary canal indistinct, appearing in one specimen to be from the commissural vessel close to where it arises from the dorsal.

The *ventral* vessel runs the whole length of the body, uniting with the dorsal as described, and sending off a good many branches from segment 4 forwards. From 14 back it gives marked vessels to the ventral body-wall in the posterior mesenteries of the segments.

15.—Cryptodrilus hulmei, Spencer.

Megascolides hulmei, Spencer. P.R.S. Vict., 1892.

Plate XVI., Fig. 15.

Dissection.—Dorsal vessel single, running the whole length of the body. From segment 17 back it gives off a pair of commissural vessels in each segment to join the ventral, supplying the alimentary canal on the way. This arrangement is apparently continued to the posterior end, but at the very end of the body the mesenteries are so thick that the vessels, which are here small, are hard to make out. From segment 13 forward the mesenteries also become extraordinarily thickened, very much obscuring the blood supply, especially that connected with the ventral vessel. From 16 forward the branches from the dorsal become irregular. In segment 16 there are two on each side, one running to the ventral and only supplying the alimentary canal (Dorso-intestinal, Bourne). In 15 there are also two, but neither of these reaches the ventral, both ending—after supplying the alimentary canal—in the *sub-intestinal*, which ends on the posterior mesentery of this segment. The anterior pair of these vessels forms a small plexus on the roof of

the alimentary canal, and from this the *supra-intestinal* arises, which runs backwards to the posterior mesentery of 15, and forwards to the front of 8. In 13 and 14 it gives off a vessel on each side to the alimentary canal, which opens into the sub-intestinal, there being no branch from the dorsal in these segments. In segments 10, 11 and 12 a pair of *hearts* arise from the dorsal and supra-intestinal in the posterior part of the segment, opening into the ventral, markedly on its under side. In segments 9-5 the dorsal gives off posteriorly in each segment a *commissural* vessel on each side, having a small connection with the ventral, and ending clearly on the septum. From segment 9 forwards the ventral is very small indeed, and its connection with these vessels becomes more and more indistinct. It seems to break up soon after its junction with that in segment 5, but may continue to the most anterior end. In segments 4, 3 and 2 the branches from the dorsal break up on the wall of the alimentary canal, while that in 5 gives off a *lateral*, running forward and downward for a short distance, and backwards and upwards at first, then dipping down as the *sub-intestinal* on each side, ending at the back of 16 as described. From 8-14 this vessel receives branches from the alimentary canal, derived from the supra-intestinal which ends blindly in front of segment 8.

16.—**Diporochaeta yarraensis**, Spencer.

Perichaeta yarraensis, Spencer. P.R.S. Vict., 1892.

Plate XVI., Fig. 16.

Dissection.—*Dorsal* vessel single, swollen in segments 13-18, less so in 10-12. At the front end it divides and runs round, apparently joining with the ventral, but both vessels are here small. At the hinder end the dorsal and ventral are joined by a single pair of commissural vessels, one on each side. Ten segments from the last, these, in one specimen, appeared to come off, not in the middle of the segment as is the case further forward, but down the mesentery. As, however, this arrangement was less marked in the next examination, and as the muscles in the mesentery are here very thick, this appear-

ance may have been due to the vessels being covered by the muscles. In the hinder part of 13 the dorsal gives off a *supra-intestinal*, running forward to end in 8. This gives rise in the posterior part of segments 10, 11 and 12 to a pair of *hearts*, each receiving, as in many others, a small branch from the dorsal. In the same position in segments 9-4 the dorsal gives off a pair of *commissural* vessels in each segment, running round to the ventral, and giving branches to the alimentary canal (B.A.) and ventral body-wall (Br.W.) on the way in segments 9-6, and in 5 sending back a *lateral*, which is continued as a *sub-intestinal* on each side in 9, 10, 11 and 12, and which in these segments receives branches from the alimentary canal, derived from the supra-intestinal, and perhaps also in segment 8.

The *ventral* is connected with the dorsal as before described, and behind the hearts gives clear branches to the ventral body wall, being single along the whole length of the body.

17.—Diporochaeta tanjilensis, Spencer.

Perichaeta tanjilensis, Spencer. P.R.S. Vict., 1892.

Plate XVI., Fig. 17.

Dissection.—Dorsal vessel single, swollen in segments 13-16, and joining the ventral by a single commissural branch on each side at the posterior end of the body. This arrangement continues in each segment till 13, in which the dorsal gives off as well a *supra-intestinal*, swollen in segments 10-12, and running forward to the front of 8. The dorsal runs forward to the first segment, possibly passing to the ventral surface, but is here very small, and gives off a pair of *commissural* vessels on each side in the posterior parts of segments 9-5, those in 9-6 giving branches to the ventral body wall (Br.W.), that in 5 giving a branch running back as the *lateral* on each side, and receiving vessels from the alimentary canal, derived from the supra-intestinal in segments 8-12. A pair of *hearts* arise at the back of the segment from the supra-intestinal in 10, 11 and 12, and run round to the ventral vessel, each receiving a very small branch from the dorsal at their point of origin.

The *ventral* is single, giving off from segment 13 backwards clear vessels to the ventral body wall. This form, though not identical with *D. yarraensis*, is closely similar to it in circulatory system, as in others (compare Professor Spencer 13).

18.—Diporochaeta copelandi, Spencer.

Perichaeta copelandi, Spencer. P.R.S. Vict., 1892.

Plate XVI., Fig. 18.

Dissection.—Dorsal vessel single, swollen in segments 10-17, and breaking up in segment 1. It is connected with the ventral by a pair of commissural vessels in each segment, as far forward as 14, and gives out in the hinder part of segment 13 a *supra-intestinal*, which runs forward to break up in 8. From the back of 10, 11 and 12 this receives a small branch from the dorsal on each side, and from the junction of the two a pair of *hearts* arise in each segment, or, as in most cases in which there is a branch from the dorsal in these segments, the hearts may be regarded as having two points of origin. The hearts run round to join the ventral vessel, and from segments 9-5 the dorsal gives off from the back of the segment a pair of commissural vessels, which do likewise. In 5 this vessel is very small and indistinct, and in 6 it runs through a curious glandular structure. In 7 it seems to give off backwards, from the middle of a similar gland, a *lateral* vessel on each side. In 10 these become the *sub-intestinal*, and that of the right side sends a branch to that of the left, running on for a short distance, and then disappearing, while the left continues as the single sub-intestinal, ending in the posterior part of segment 13, and receiving in 10, 11, 12 and 13, branches from the alimentary canal, derived from the supra-intestinal.

The *ventral* vessel becomes very small at the anterior end, and does not appear to unite with the dorsal. It gives off branches to the posterior system of the segment from 14 backwards.

19.—**Diporochaeta bakeri**, Fletcher.

Perichaeta bakeri, Fletcher. Proc. Linn. N.S.W., vol. ii., 1897.

Plate XVI., Fig. 19.

Dissection.—Dorsal vessel single, running forward to break up in segment 1, and joining the ventral by a commissural vessel on each side at the most posterior end. It is swollen in 10-17, and connected with the ventral by a pair of *commissurals* in each segment, till the posterior part of segment 12, where it gives off a *supra-intestinal*, running forward to break up in 8. The supra-intestinal apparently receives a small branch from the dorsal on each side in 10 and 11, and in 10, 11 and 12 from the back of the segment, at the junction of the branch from the dorsal with the supra-intestinal arises a *heart* on each side. In segments 9-5 commissurals arise from the dorsal, and pass to the ventral vessels, giving branches to the ventral body-wall (Br.W.) on the way. In segment 4 this vessel from the dorsal seems to end on the alimentary canal wall, and in 6 it apparently gives off a branch, running backwards as the *lateral*, though the point of junction in the specimens examined was not very clear. The lateral runs on as the *sub-intestinal* on each side, in 10, 11 and 12 receiving branches from the alimentary canal, derived from the supra-intestinal, and ending on the posterior mesentery of segment 13.

The *ventral* is single along the whole length of the body, breaking up in segment 1, and appearing to give branches to the ventral body-wall behind the hearts.

From the foregoing description it will be seen that, as far as may be stated from the limited number of worms examined:—

1. The number of hearts seems to be fairly constant, three being the usual; but they may tend to increase as in *P. dorsalis*, *P. coxii* and *P. fielderi*, the last showing this characteristic markedly. Beddard (1) remarks that the position of the last heart is not a character subject to variation.

2. That the hearts may be always distinguished from mere swollen vessels by their connection with the supra-intestinal, except in the case of *D. davallia*, as described.

3. That as far as can be made out from dissections there seems to be a correlation between the anterior ending of the supra-intestinal vessel and the origin of the hearts—when the former opens into the dorsal vessel at the anterior end the hearts having no connection with the dorsal; but if the supra-intestinal merely breaks up, the hearts take origin from both it and the dorsal, except in the case of *D. davallia* and *C. gippslandicus*, in which the anterior junction of the supra-intestinal and dorsal is very fine, if present. This worm, however, is aberrant in other particulars, e.g., the double dorsal vessel, so it may not be possible to place it under any generalised heading.

4. That the function of the hearts is mainly propelling, though they may give off branches, supplying organs in their course—e.g., nephridia; and the place of the ordinary one or more commissural vessels, passing from the dorsal to the ventral behind the hearts, and supplying the alimentary canal on the way, is in their region, taken by the branch from the supra-intestinal, which is in some cases very large.

5. That the supra-intestinal varies in the position of its origin, but is apparently always connected with the dorsal at or close to its hinder end.

6. That the lateral is a constant feature, though varying in its point of origin—seeming, however, most frequently to arise from the commissural vessel in segments 4 or 5. That it is not always observed to divide into a forward and a backward running portion may be due to the small size of the former, though in many it was most marked. Bourne (11), in a note on p. 62, says, "These vessels (Intestino-tegumentary), or at any rate, some having similar relations, have been stated to communicate directly with the dorsal vessel in Limbricus." In *M. coeruleus*, however, the only direct connection of the intestino-tegumentary with the dorsal, which he describes, is in the capillary network at the anterior end. The lateral usually runs on as a separate sub-intestinal on each side, but occasionally the two become united; while in some cases, as in *P. dorsalis* and *P. tenax*, at the anterior end it seems to take an important function in relation to the supply of the ventral body-wall, and presumably of the nephridia. Howes (12)

figures an infra-intestinal vessel, and Beddard (2) describes a single sub-oesophageal vessel in Acanthodrilus, while in *Typhaeus gemmii* (3) he mentions the lateral, which supply the gizzard, and run below the intestine close to each other; so that the single or double character of the sub-intestinal is evidently a variable feature.

7. There seems to be no evidence in Australian forms of the existence of the subneural vessel. Beddard (2), in reference to this structure, says (p. 473), "The subneural blood-vessel, which does not appear to be present in any genera of Oligochaeta, which have been referred to Claparede's division of the Limicolae, is also wanting in some earthworms. Perrier has denied its existence in *Portodrilus* and *Perichaeta*, and Benham states it is also absent in *Microchaeta*. It is therefore of some little importance to note that this blood vessel is not invariably absent in the genus *Perichaeta*."

8. That the general rule is for the dorsal to be a single vessel, and that even where it is double, as in *M. goonmurk* and *C. gippslandicus* the ventral is single. Beddard (4), quoting from Balfour, Comparative Embryology, vol. i., p. 282, says that the existence of a double dorsal vessel seems an embryonic character, because the single vessel in *Lumbricus* and *Criodrilus* is formed by coalescence of two vessels at first distinct. In the same paper he describes the double vessel in *Microchaeta rappi;* and in (2) one in *Acanthodrilus annectens;* also in *Acanthodrilus antarcticus* (3). There are many other recorded examples, e.g., Benham (7) in *Microchaeta papillata; Acanthodrilus haplocrystis* (8); at the anterior end of *Pleurochaeta* (9); in *Dinodrilus beddardi* (10); and others, e.g., Bourne (11).

9. That the blood supply to the alimentary canal and related structures at the anterior end is generally more or less in the form of a plexus (compare Bourne, 11), which may be associated with the much-divided structure of the salivary gland. At the hinder end the supply is simple, being mainly from the commissural vessels.

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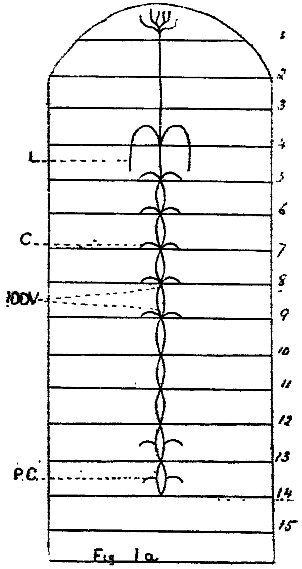

Fig 1a

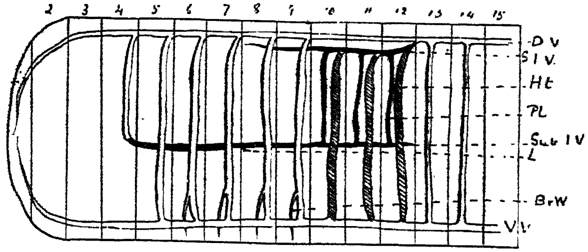

Fig 1 CRYPTODRILUS GIPPSLANDICUS

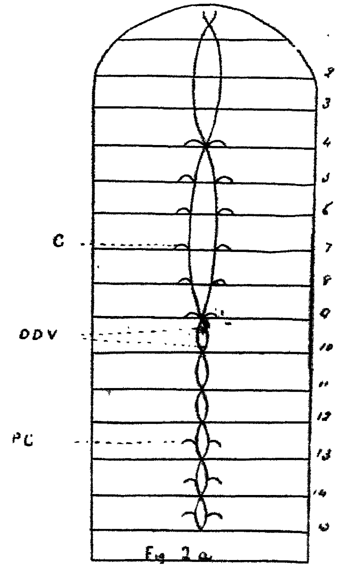

Fig 2a

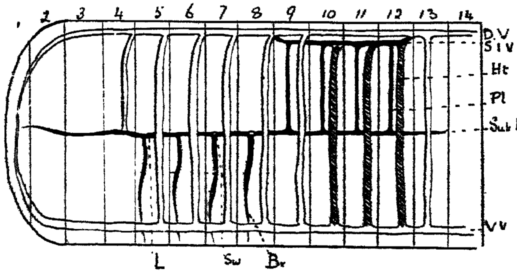

Fig 2 MEGASCOLEX GOONMURK

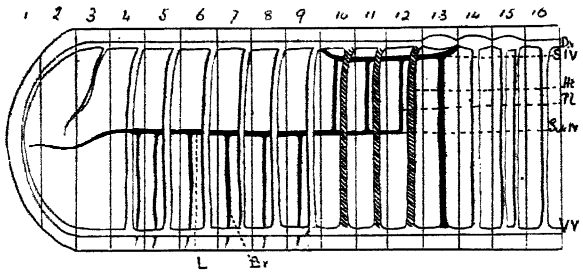

Fig 3 DIPOROCHAETA DAVALLIA

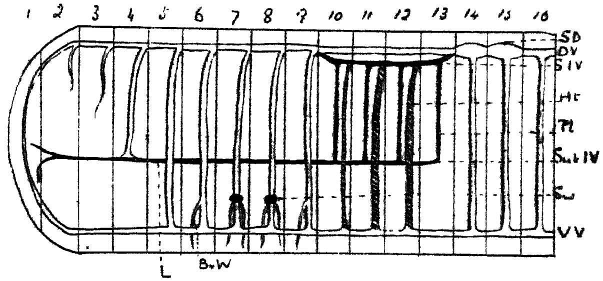

Fig 4 MEGASCOLEX TENAX

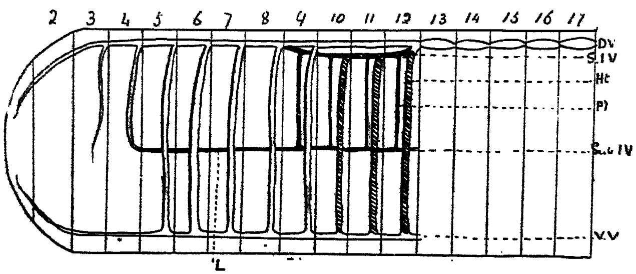

Fig 5 PERICHAETA OBSCURA

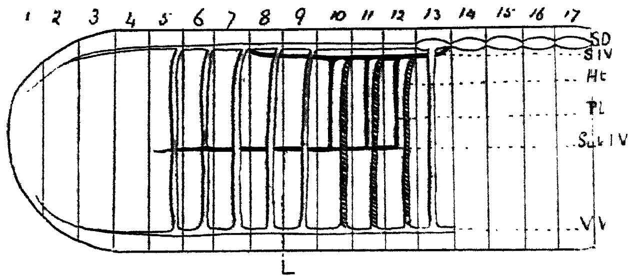

Fig 6 PERICHAETA MANNI

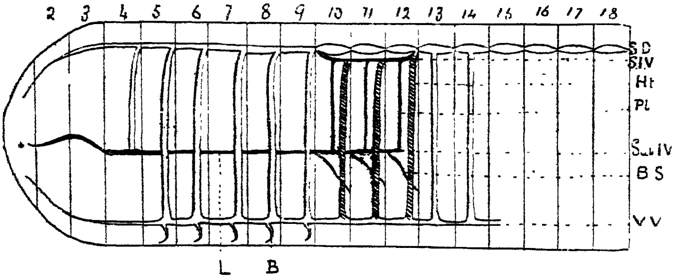

Fig 7 PERICHAETA MACQUARIENSIS

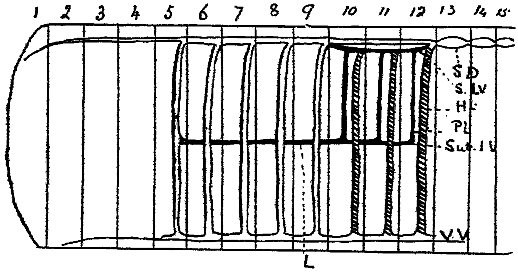

Fig 9 PERICHAETA RICHARDI

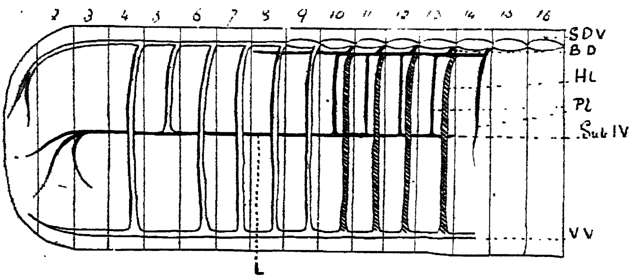

Fig 11 PERICHAETA FIELDERI

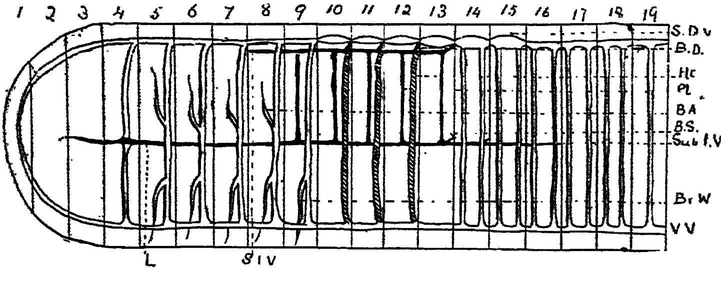

Fig 13 DIGASTER EXCAVATA

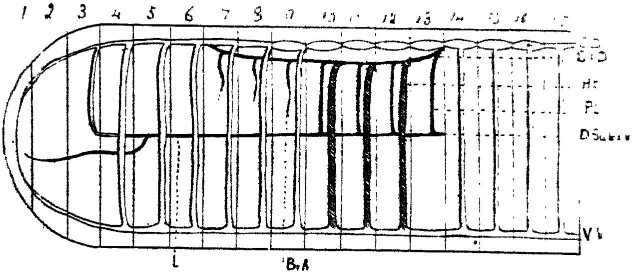

Fig 8 PERICHAETA VALIDA

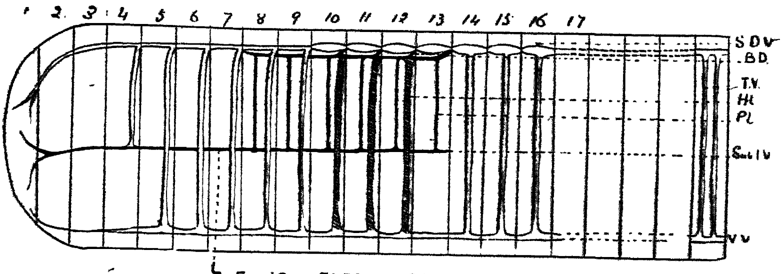

Fig 10 FLETCHERODRILUS UNICUS

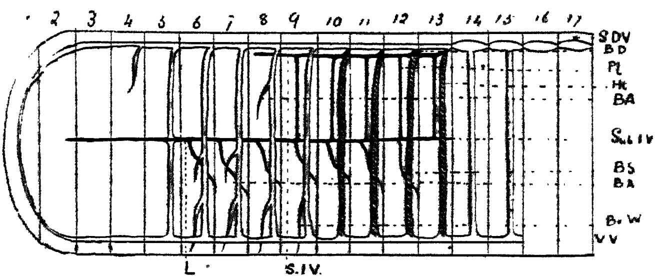

Fig 12 PERICHAETA DORSALIS

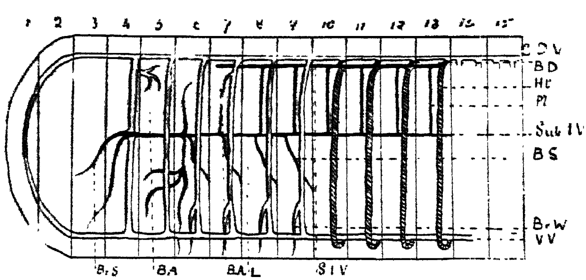

Fig 14 PERICHAETA COXII

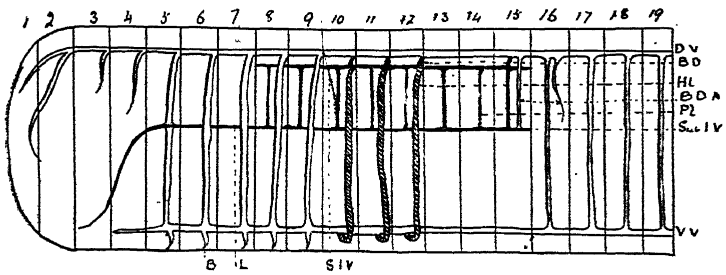

Fig 15 MEGASCOLIDES HULMEI

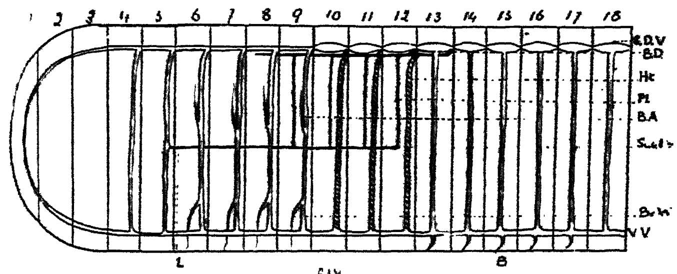

Fig 16 PERICHAETA YARRAENSIS

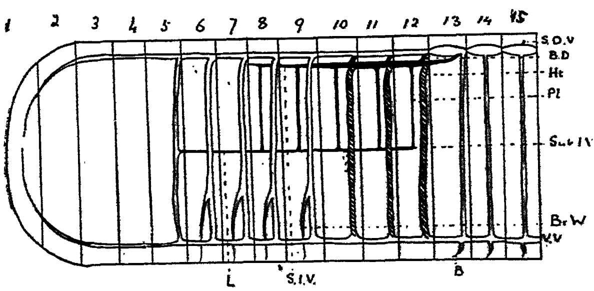

Fig 17 PERICHAETA TANJILENSIS

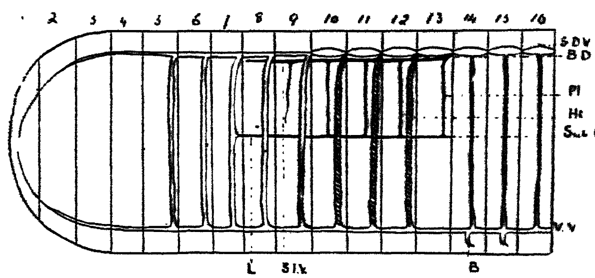

Fig 18 PERICHAETA COPELANDI

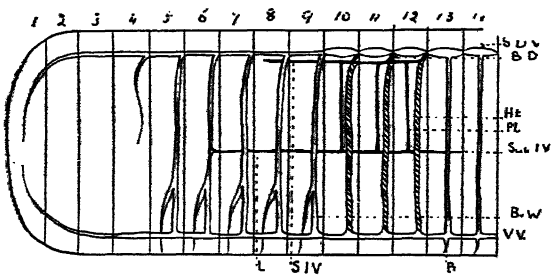

Fig 19 PERICHAETA BAKERI

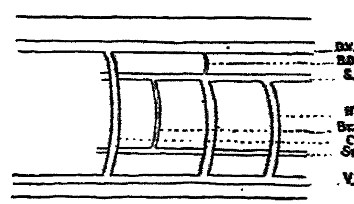

Fig. A

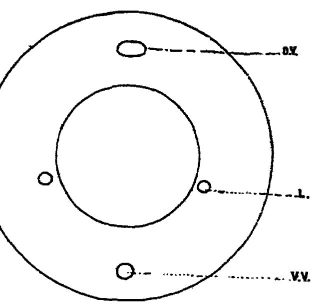

Fig. B

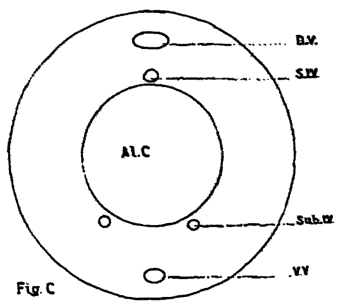

Fig. C

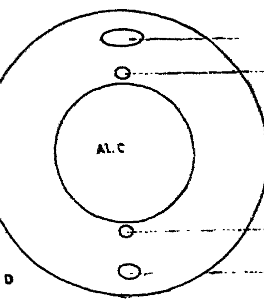

Fig. D

Fig 20

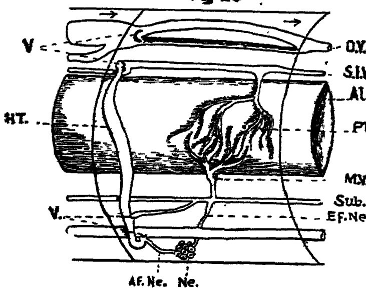

Fig. 21

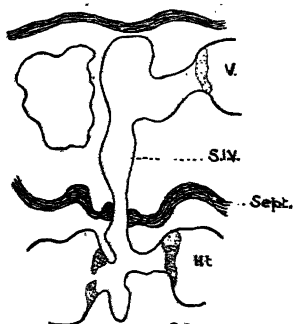

Fig. 22a

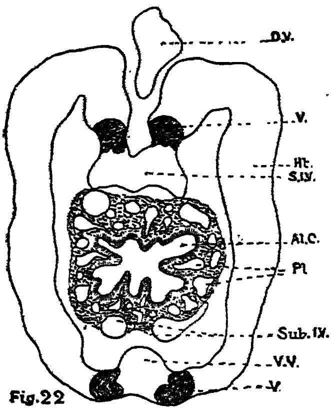

Fig.22

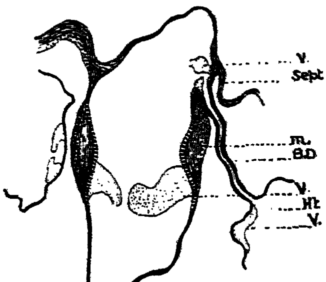

Fig. 22b

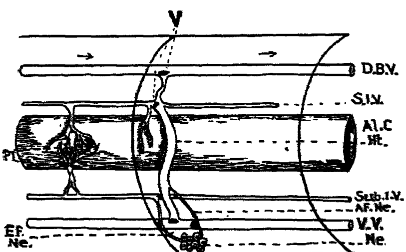

Fig. 23

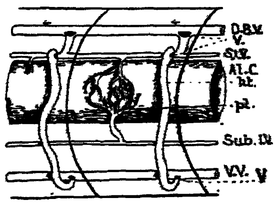

Fig. 24

EXPLANATION OF PLATES XIV-XVII.

Figs 1-19—Side views of cephalic blood vessels of the earthworms named

„ 1a, 2a—Dorsal views of those of *C. gippslandicus* and *Megascolex goonmurk*, to show the double vessel.

„ 20—Blood supply in one segment in the region of the hearts in *C gippslandicus*, constructed from serial sections.

„ 21—High power of a valve of ventral vessel of *F. unicus*.

„ 22—Compiled low power drawing of a transverse section of the blood vessels of one segment in the heart region of *F. unicus*.

„ 22a—Low power of horizontal section of the supra-intestinal vessel and hearts in *F. unicus*.

„ 22b—Lower power of horizontal section of dorsal vessel in *F unicus*, showing connection with heart

„ 23—Blood supply in one segment in the region of the hearts in *F. unicus*, constructed from serial sections.

„ 24—Blood supply in one segment in the regions of the hearts in *P. fielderi*, constructed from serial sections.

A—Diagram of longitudinal arrangement of vessels in anterior part of earthworm

B—Diagram of vessels in transverse section in region anterior to hearts.

C—Diagram of vessels in transverse section in region of hearts, showing two subintestinals.

D—Diagram of vessels in transverse section in region of hearts, showing one subintestinal.

REFERENCE LETTERS.

Al. C. - -	Alimentary Canal.
Af. Ne. - -	Afferent nephridial vessel
B. - - -	Branch of ventral and body wall.
B. A. - -	Branch to alimentary canal from commissural vessel
B. D. - -	Branch from dorsal to heart.
B. D. A. - -	Branch from dorsal to alimentary canal.
Br. - - -	Branch of lateral to body wall.
Br. A. - -	Branch to alimentary canal from supra-intestinal.
Br. W. - -	Branch from commissural vessel to body wall.
B. S. - -	Branch to septum from subintestinal.
C. - - -	Anterior commissural vessel.
D. D. V. - -	Double dorsal vessel.
D. Sub. I. V. -	Double subintestinal vessel.
D. V. - -	Dorsal vessel.
Ef. Ne. - -	Efferent nephridial vessel.
F. C. - -	Flattened cells.
Ht. - - -	Heart.
L. - - -	Lateral vessel.
M. - - -	Muscle.
M. C. - -	Muscle cells.
M. V. - -	Median vessel.
Ne. - - -	Nephridium.
P. C. - -	Posterior commissural vessel.
Pl. - - -	Plexus on alimentary canal wall.
S. D. - - -	Swellings on dorsal vessel.
S. - - -	Septum.
S. I. V. - -	Supra-intestinal vessel.
Sub. I. V. - -	Subintestinal vessel.
Sw. - - -	Muscular swellings.
T. V. - -	Posterior commissural vessels.
V. - - -	Valve.
V. V. - - -	Ventral vessel.
W. - - -	Wall of blood vessel.

[Proc. Roy. Soc. Victoria, 22 (N.S.), Pt. I., 1909.]

Art. VIII.—*Notes on the Structure of Asymmetron bassanum, Günther.*

By ETHEL REMFREY MORRIS, M.Sc.,

AND

JANET RAFF, B.Sc.

(Plates XVIII.—XX.).

[Read 8th July, 1909.]

Whilst working in the Biological Laboratory of the Melbourne University, our attention has been drawn to certain points in the structure of *Asymmetron bassanum*, which either have not hitherto been noticed, or have not been adequately described. This species is not uncommonly met with at depths up to twenty fathoms in certain rather restricted areas along the Victorian coast, and, as it is commonly employed in our laboratories in substitution for the genus Amphioxus, the description of which is given in all text-books, we have, at the suggestion of Professor Spencer, placed on record the following brief notes:—

1.—External Structure.

The average length of twelve specimens is 39 mm.; the average number of myotomes, 75; the average myotome formula, 44, 17, 14.

The ventral fin has chambers and fin rays, which are single (Fig. 4), but which may appear double when cut at certain angles (Fig. 9). The rostral fin is large.

At the anterior end there is always present an incomplete ring of pigment (Fig. 11), just in front of the first myotome.

The oral cirri are 24-26 in number, and bear sense papillae. The velum is placed at the level of the seventh myotome, and bears 16-18 tentacles.

The gonads are arranged in a single series on the right side, and vary in number from 25-30.

The left metapleur stops behind the atriopore; the right is continuous with the median ventral fin.

2.—Pigment Ring.

A very marked feature of the species is the presence of an incomplete ring of pigment in the rostral fin. It is situated about .6350 mm. from the tip of the snout immediately in front of the first myotome, and is about .0635 mm. in thickness (Fig. 11). The pigment material lies in the cuticle, and extends dorsally and ventrally to varying distances in different specimens. In some of the sections examined the pigment was continued right over the dorsal surface, and stops short ventrally, thus forming an incomplete ring (Fig. 12). In others it did not extend over the whole dorsal surface, but continued further ventrally into the oral folds for a short distance. It is always present, however, as two thick bands on each side of the body, and varies only in its extension dorsally and ventrally. The olfactory pit and eye spot lie in the ring of pigment.

Pigment material is also developed in the different spaces in the body. In front of and in the region of the pigment ring it is thickly developed in the dorsal and ventral portions of the fin, and also in the spaces surrounding the notochord. Beyond the ring the pigment surrounds the nerve cord and notochord, and lines the dorsal fin space and the coelum. It runs down the right and left portions of the oral hood, where it is very thickly developed (Fig. 13).

3.—Atrial Cavity.

At the anterior end of the body the atrial cavity forms a large space around the ventral and lateral regions of the pharynx. It extends backwards surrounding the alimentary canal, and separating the coelom from the body-wall, and opens to the exterior by means of the atriopore about two-thirds of the way down the body (Fig. 1). Beyond the atriopore the cavity is continued back (Fig. 2), and divides into two caeca surrounding the intestine, and separating the coelom

from the body wall, except on the ventral surface (Figs. 3 and 4). The left post-atrioporal caecum stops a short distance behind the atriopore (Fig. 5); the right is longer and extends almost to the anus (Fig. 6).

In Fig. 8 the relative lengths of the caeca and coelom are represented.

Taking the distance between the termination of the right atrioporal caecum and the anus as one, the following are the relative proportions:—

Between the atriopore and the posterior termination of the left atrial caecum—8.

Between the posterior termination of the left caecum and the posterior end of the right—20.5.

Between the end of the right caecum and the anus—1.

Extension of coelom behind the atriopore, i.e., to the anus—29.5.

4.—Coelom.

The coelom extends from the anterior end of the body to the anus. In the region of the pharynx it is much reduced by the atrial cavity being represented by paired cavities on its dorsal surface, with prolongations down the primary gill-bars communicating with the endostylar coelom on the ventral surface. Beyond the pharynx it is a small cavity surrounding the intestine, the atrium occupying the greater part of the space within the body wall. Just beyond the atriopore the coelom is still confined to a small space owing to the prolongation of the atrial cavity (Fig. 2), and becomes more spacious as the caeca die out (Figs. 3, 4, 5, 6), and ends in the region of the anus (Fig 7).

5.—Classification.

There is some uncertainty as to the position of *Asymmetron bassanum*. Miss J. W. Kirkaldy, in a paper in the Q.J.M.S., vol. xxxvii., divides the family *Branchiostomidae* into two genera—Branchiostoma and Asymmetron. The former she sub-divides into two sub-genera—Amphioxus and Heteropleuron—and classifies the species in question as *Heteropleuron bassanum*. But the chief features in the species—viz., the unilateral metapleural folds, and the single series of gonads, were found

to agree more closely with the characters of the genus Asymmetron than with those of the genus Branchiostoma, so a new classification was formed by W. M. Tattersall, B.Sc., in his paper in the Trans. Liverpool Biol. Soc., vol. xvii., where he places the species in the genus Asymmetron. He divides up the genus as follows:—

A.—Species in which a urostyloid process is absent; oral cirri are present, and bear sense papillae; ventral fin is divided up into fin chambers; single post-atrioporal caecum.

(i) Ventral fin possesses both chambers and rays.

A. bassanum.
A. hectori.
A. maldivense.
A. cingalense.

(ii.) Ventral fin has fin chambers, but no rays.

A. cultellum.

B.—Species with a long urostyloid process, into which the notochord is prolonged; oral cirri have no sense papillae; post-atrioporal caecum paired; ventral fin has neither fin rays nor chambers.

A. lucayanum.
A. caudatum.

From the description of the species we see there is a paired post-atrioporal caecum present, so we need to alter Tattersall's classification slightly, and arrange group A as follows:—

Genus Asymmetron.

A.—Species in which a urostyloid process is absent; oral cirri are present, and bear sense papillae; ventral fin is divided up into fin chambers.

(i.) A single post-atrioporal caecum.

(a) Ventral fin possesses both chambers and rays.

A. hectori.
A. maldivense.
A. cingalense.

(b) Ventral fin has chambers but no rays.

A. cultellum.

(ii.) A paired post-atrioporal caecum.

A. bassanum.

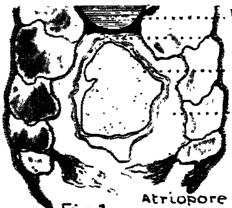

Fig. 1

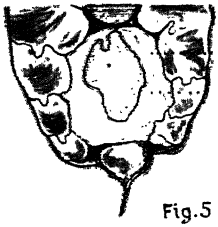

Fig. 5

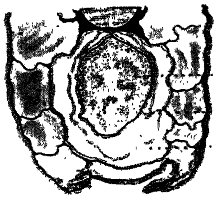

Fig. 2

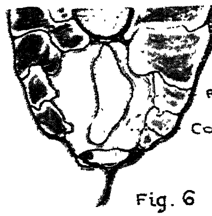

Fig. 6

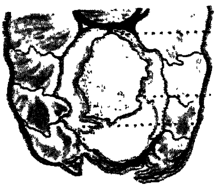

Fig. 3

Fig. 7

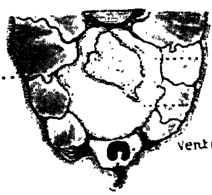

Fig. 4

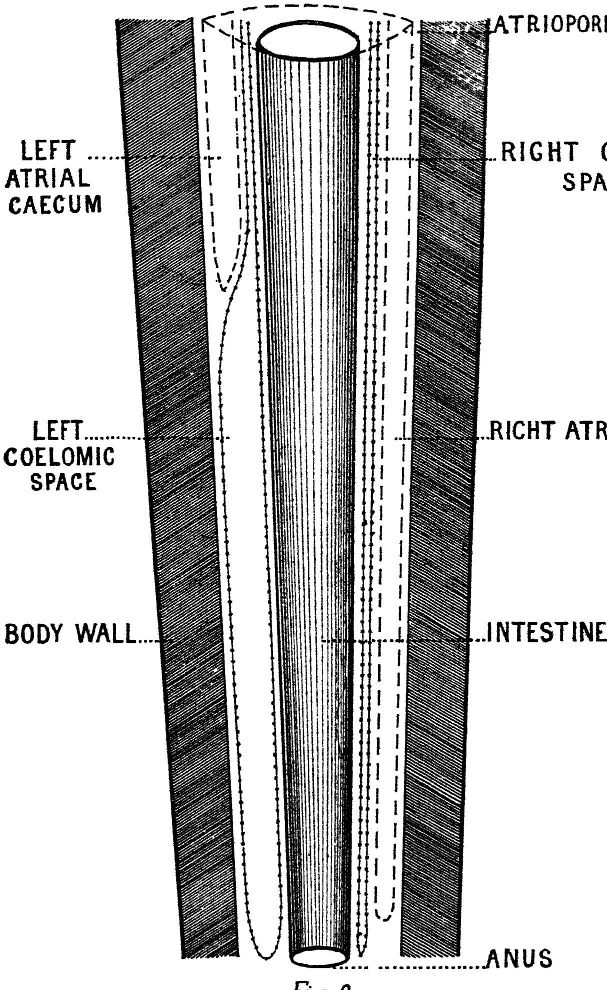
ATRIOPORE.
LEFT ATRIAL CAECUM
RIGHT COELOMIC SPACE
LEFT COELOMIC SPACE
RICHT ATRIAL CAECUM
BODY WALL
INTESTINE
ANUS

Fig. 8

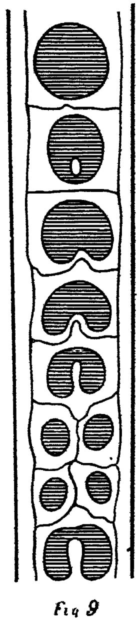

Fig. 9

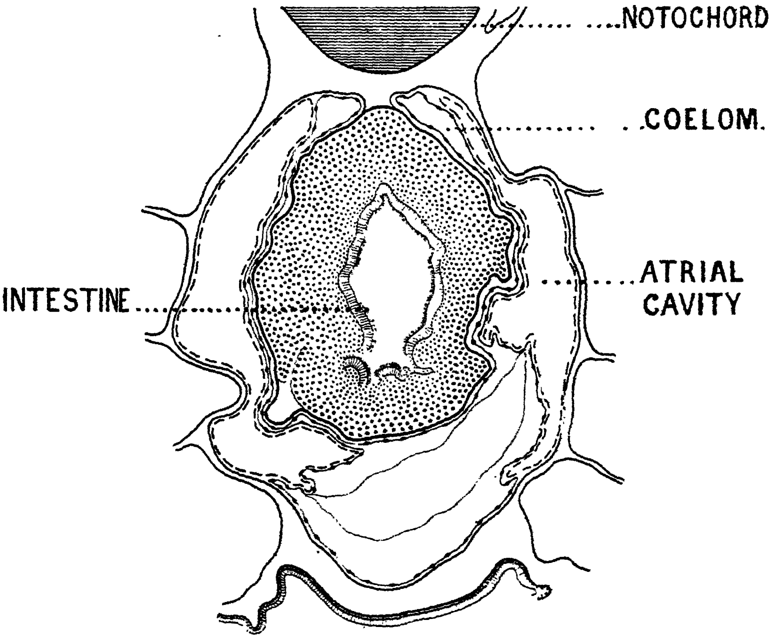

Fig 10

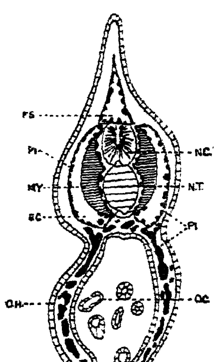

FIG 13

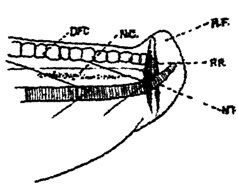

FIG 11

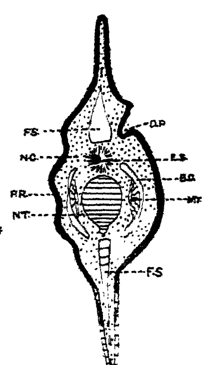

FIG. 12

EXPLANATION OF PLATES

In all figures

B C.	Coelom
D. F. C.	Dorsal fin chambers
E. S.	Eye spot.
F. S	Fin space.
MY	Myotome.
N. C.	Nerve cord.
NT.	Notochord.
O. C.	Oral cirri.
O. H.	Oral hood.
O. P.	Olfactory pit.
PI.	Pigment.
P. R.	Pigment ring

Plate XVIII

Fig. 1—Transverse section through region of atriopore, showing atrial cavity extending between coelom and body wall except in mid-dorsal region.

„ 2–6—Transverse sections behind atriopore.

„ 2—Atrial cavity still separating coelom from body wall except dorsally.

„ 3—Atrial cavity divided into two caecae, right and left.

„ 4—Showing right and left atrial caecae—the left close to its termination. Ventral fin ray also shown.

„ 5—Left atrial caecum has disappeared completely.

„ 6—Termination of right atrial caecum.

„ 7—Transverse section through region of anus. Atrial cavity has completely disappeared.

Plate XIX.

Fig. 8—Diagrammatic longitudinal section showing (1) atriopore, (2) anus, (3) coelom extending posteriorly on either side as far as the anus, (4) right and left atrial caecae extending posteriorly between coelom and body wall.

„ 9—Diagrammatic longitudinal horizontal sections of ventral fin rays cut at various angles.

Plate XX.

Fig. 10—Diagrammatic transverse section behind atriopore showing right and left atrial caecae as in Fig. 3.

" 11—Anterior end showing incomplete ring of pigment around anterior end of notochord.

" 12—Drawing compiled from a series of transverse sections through the pigment ring.

" 13—Transverse section through oral hood showing pigment in spaces.

[Proc. Roy. Soc. Victoria, 22 (N.S.), Pt. I., 1909.]

Art. IX.—*Contributions to the Flora of Australia, No. 12.*[1]

BY

ALFRED J. EWART, D.Sc., Ph.D., F.L.S.

(Professor of Botany in Melbourne University and Government Botanist),

AND

JEAN WHITE, D.Sc.

(Victorian Government Research Bursar.)

(With Plates XXI.-XXVI.).

[Read 8th July, 1909.]

Acacia leucosperma, F. v. M., ined., and E. Pritzel, n. sp. (Leguminosae). Fragm. Phyt. Aust. Occid., p. 302: Engler's Botanische Jahrbücher, Bd. xxxv., 1905, p. 302.

Under this head Pritzel has described a West Australian Acacia partly from new material and partly from a specimen from near L. Austin, West Australia, H. S. King, labelled by Mueller "*Acacia leucosperma*, F. v. M." This plant was, however, published as *A. spodiosperma*, F. v. M., in the Proceedings of the Linnæan Society of New South Wales, 1868, vol. 3, p. 164. Pritzel gives broader phyllodes (2.4 mm.) than in the type specimen; but a later one from the Gascoyne River (Mrs. Gribble, 1886) has equally broad single-nerved phyllodes. The name *A. leucosperma* is therefore merely a synonym for *A. spodiosperma*, F. v. M.

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1 No. 11 in Proc. Roy. Soc. Victoria, vol. xxii., pt. i., 1909, p. 6.

ACACIA RAMULOSA, W. V. Fitzgerald. Journal W. Aust. Nat. Hist. Soc., p. 15, 1904 = A. BRACHYSTACHYA, Benth. (Leguminosae).

Watheroo Rabbit Fence, West Australia. Max. Koch, Sep., 1905. No. 1662. New for W. Australia.

The specimen was labelled from another source (probably Diels and Pritzel), "*Acacia stereophylla*, Meissn., syn. *A. cibaria*, F. v. M., and *A. ramulosa*, W. V. Fitzgerald." It has, however, the rounded heads of *A. brachystachya* instead of the more elongated ones of the two first-named species. Otherwise *A. cibaria*, F. v. M., appears close to *A. brachystachya*, and was, in fact, marked by Mueller, "Forsan *A. brachystachya*." Fitzgerald's species was described from a specimen without flowers. The cylindrical fruit at once distinguishes all these "species" from the flat-fruited *A. aneura*.

ANGIANTHUS MICROPOIDES, Benth., var filaginoides. (Compositae). PHYLLOCALYMMA FILAGINOIDES, Steetz. Pl. Preiss, I., 437, No. 37.

This was reduced by Bentham to a synonym of *A. micropoides*, but there seems sufficient distinction to recognise a variety. The plants are more slender and branching, the floral leaves of the general involucre are narrower and longer, the flowers and achenes a deeper colour, pappus scales and awn shorter, the former more jagged.

ANGIANTHUS STRICTUS, var. lanigerus, n. var. (Compositae).

Differs from the type in the outer floral leaves densely covered with white wool, with bare minute reddish tips. The main stem is well developed and woolly.

Intermediate forms occur.

Woorooloo, West Australia, Max Koch, Oct., 1907. No. 1873.

CALOTIS PLUMULIFERA, F. v. M. (Compositae).

Watheroo Rabbit Fence, W. Australia. Max Koch, Dec., 1905. No. 1897. No. 1896 is a dwarf form of the same species.

CRYPTANDRA APETALA, Ewart and White, n. sp. (Rhamnaceae).

A shrubby plant, more than 10 inches high, with divaricate branches which do not bear spines. The ends of the young branches are slightly pubescent. Leaves linear-lanceolar, situated in tufts on short lateral branches, shortly petiolate, somewhat obtuse and covered with short felt-like greyish hairs, especially on the under surface; the margins are so revolute as to make the leaves almost terete.

Flowers situated in clusters on short lateral shoots, towards the upper branches of the shrub; each flower is sessile, and there are from 2—8 flowers in each cluster. The brown bracts are much shorter than the calyx lobes, and are obtuse; the whole calyx is about 1 line long, and both limb and tube are densely covered with an appressed pubescence of small, greyish hairs. The calyx is tubular, urceolate to slightly campanulate in shape, the lobes about the same length as the tube, sepals 5, brownish pink in colour, and slightly thickened at the tips. The petals are absent, and there are 5 stamens with comparatively large anthers, the filaments being inserted on the calyx at their base, between each pair of sepals.

Disc pubescent, forming a prominent rim round the small central depression in which the style arises. Stigma shortly trilobed. Ovary attached to the calyx tube.

Cowcowing, W. Australia; M. Koch, Sept., 1904. No. 1596.

The plant resembles C. polyclada, Diels, externally, but differs entirely in the bracts and flower. Its nearest affinity is *C. tomentosa*, Lindl., a specimen of *C. tomentosa* from L. Albacutya, having the tomentose character of the calyx equally well developed; but it is easily distinguished from that species by the absence of petals, the calyx tomentose all over the outside, and the sessile more sparsely scattered flowers. In the absence of petals and in the disc it shows an approach to *Colletia (Discaria)*, from which, however, it differs widely in habit.

DROSERA ANDERSONIANA, W. V. Fitzgerald, ined. Ewart and White, n. sp. (Droseraceae).

Rootstock apparently not bulbous. Stems more or less erect, 6 to 9 inches long, not so slender as in *Drosera penicillaris*.

Lower leaves well developed, rather large, in fine specimens about 3 lines in diameter, rosulate, orbicular, not peltate. Stem leaves situated usually in groups of three, of which one is larger and has a much longer pedicel than the other two, the smaller leaves being about 1 line in diameter, the larger 2 to $2\frac{1}{2}$ lines, all with long marginal glandular hairs, and the stem leaves very slightly angled. Pedicels slender and from $\frac{1}{2}$ to $\frac{3}{4}$ inch in the lower leaves, and $\frac{3}{4}$ to 1 inch long in the larger stem leaves. Stipules absent.

Flowers, several, situated on a loose cyme, peduncles as long or longer than the flowers, and slightly hairy. Sepals 5, free, except at the base, somewhat hairy, about 1 line long. Petals 5, free, pink or red, about twice the length of the sepals.

Stamens 5, anthers 2-celled and almost circular. Ovary comparatively large, style much divided into numerous dichotomous branches.

Cowcowing, W. Australia, Max Koch, 1904. No. 1106 (with the unpublished manuscript name, D. Andersoniana, W. V. Fitzgerald).

Although the plant bears some resemblance to *Drosera penicillaris*, Benth. (*D. Drummondii*, Planch.), it is easily distinguished by the basal leaves, non-flexuose stem, and dichotomously divided styles. The size of the leaves readily separates it from D. Menziesii, R. Br., and *D. macrantha*, Endl. Investigations upon the amount and degree of variation in the character and branching of the styles in the genus *Drosera* would be of great value. It is possible that too much importance is attached to this feature in the classification of species.

EUPHORBIA DRUMMONDII, Boiss. (Euphorbiaceae).

This little weed, spread over the whole of Australia and Tasmania, is endemic to Australia, and though very common, does not appear to have been figured. As noted by Bentham, the plant, apart from its glabrous character, bears a strong resemblance to *E. chamaesyce*, L. Owing to a typographical error, this name is given in Bentham's Flora Australiensis (vi., p. 49) as *E. chamaesyee*, which is repeated in the Kew Index as *E. chamaesgec*. Mueller (Native Plants of Victoria, p. 105) suggests that *E. Drummondii* may be a variety only of

E. chamaesyce. It is true that some specimens of the latter are nearly, or quite, glabrous; that the capsules and seeds are much alike, being quadrangular and reddish-brown turning to a grey and white, somewhat wrinkled surface, and that the stipules show similar variations of shape in both species, but *E. Drummondii* is a perennial instead of an annual, the involucre and its glands differ, and the "flowers" are more sparsely scattered and less clustered. Apart from that, it is unlikely that a species (*E. chamaesyce*) restricted to the countries around the Mediterranean, including N. Africa, should be represented by a variety spread over the whole of Australia, without any intervening forms or varieties occurring in the intervening districts, which include large tracts of country similar in character to those in which the two species flourish.

E. Drummondii has long been regarded as intensely poisonous to stock, mainly on the authority of Baron von Mueller. Careful investigations by Stanley (Agricultural Gazette of New South Wales, 1890; 1896, p. 319) have, however, shown not only that the plant is not poisonous, but that it has a certain fodder value, especially for sheep. By causing hoven or tympanitis, the plant may cause the death of sheep, but in precisely the same way as all succulent fodders may do, when sheep are allowed to gorge upon them, especially after being weakened by starvation or exhausted by travelling.

E. chamaesyce was a medicinal plant well known to the ancients, and was used by them internally as a purge, and externally for painful ulcers, warts, scorpion stings, spots on the nails, and weak eyes. Many attempts have been made to extract a poisonous principle from both these species, especially from *E. Drummondii*, but without success, so that their non-poisonous character may be regarded as definitely established.

GREVILLEA PRITZELII, Diels. Fragm. Phytog. Austr. Occid. Engler's Bot. Jahrb., xxxv., p. 150, 1905. (Proteaceae). M. Koch, Dec., 1904, No. 991.

Specimens of this shrub have been received, labelled, from one source, *Grevillea concinna*, R. Br.; syn. *G. Pritzelii*, Diels, and from another source, labelled as *G. armigera*, Meissner.

While near to both *G. concinna* and *G. Hookeriana*, the very prominent concave and tongue-like hypogynous gland readily distinguishes it from both species. Other differences lie in the frequently segmented but hardly compound leaves, more rigid and paler; the hairs outside the perianth and ovary whitish instead of brown; pedicels slightly longer; stalk of ovary somewhat shorter.

Montia fontana, L. (Portulaccaceae).

This small cosmopolitan was originally recorded (in Australasia) from Tasmania, and later was found in Victoria and New South Wales. A specimen of it in the Herbarium from Perth was originally queried as *Tillaea*, and was apparently collected by W. V. Fitzgerald. It will probably be found over the whole of the south of Australia. Some of the specimens approach the variety recognised as a species by Gmelin (M. minor, Gmelin, Fl. Bad., i., 301). The plants are, however, practically identical. (See Pl. XIX., Fig. 4).

Podopetalum Ormondi, F. v. M. (Leguminosae).

This Queensland plant was made the type of a new genus by Mueller (Melbourne Chemist and Druggist, June, 1882), but without describing the species, which is accordingly referred in the Kew Index to "F. v. M. Census, nomen." Bailey refers the species to the first citation. The specific description is, however, given in the Garden and the Field, April, 1884, p. 174, and as that may be inaccessible, is here repeated.

"Pod on a stipe of rather more than half an inch, somewhat compressed; valves coriaceous, tardily separating, hardening through exsiccation, to $\frac{3}{4}$ inch or more wide, contracted between the seeds, dorsally undulating, becoming black outside; pithy cross walls imperfect or absent; funicle thick, very short, strophiole none; seeds few, roundish to quadrangular, $\frac{1}{3}$ to $\frac{1}{2}$ inch, slightly compressed; hilum roundish oval, about 1 line long; testa thinly crustaceous, smooth, bright scarlet; albumen, none; embryo pale yellowish, horny when dry; radicle very short, next to the hilum."

A tree fifty feet high, bark smooth and greyish, flowering for several months, so that blossoms and pods are present at the same time (December).

The accompanying figures were prepared from the pencil sketches of R. Graff, with a few small corrections. A plate appears to have been actually lithographed, since a proof exists at the Herbarium, but not to have been issued.

In Engler's Pflanzen Familien, iii., 3, 193, the species is given as native to New Zealand, which is an error for Queensland.

TRICHINIUM (PTILOTUS) INCANUM, R. Br, var. intermedium, n. var. (Amarantaceae).

R. Helms (Elder exploring expedition), Warrina, S. Aust., May, 1891.

The plant has the cylindrical inflorescence and transparent woolly bracts of *T. incanum*, but the indumentum of the stem and the larger flowers of *T. obovatum*, Gaud. The *T. incanum* of Moquin is referred by Bentham to *T. obovatum*, and it is possible that the two species may ultimately prove to be varieties of one species.

Var. PARVIFLORUM, n. var. (PTILOTUS HELMSII, F. v. M. and Tate, ined.).

Elder exploring expedition, Camp 4, S. Australia, R. Helms, July, 1891. The flowers have constantly 3 stamens, the heads are fewer flowered, the bracts are darker in colour, the hairs of the woolly indumentum are longer and looser, and the young shoots less densely white and woolly.

EXPLANATION OF PLATES

Plate XXI.—Cryptandra apetala, Ewart and White

Fig. 1 Part of branch of Cryptandra Nearly natural size
2. Leaf of Cryptandra. Enlarged.
3. Diagram of a leaf cut across. Enlarged.
4. Small portion of a branch, showing the inflorescence.
5 Longitudinal section through flower Enlarged.
6 One of the brown bracts Enlarged

Plate XXII.—Drosera Andersoniana, Ewart and White.

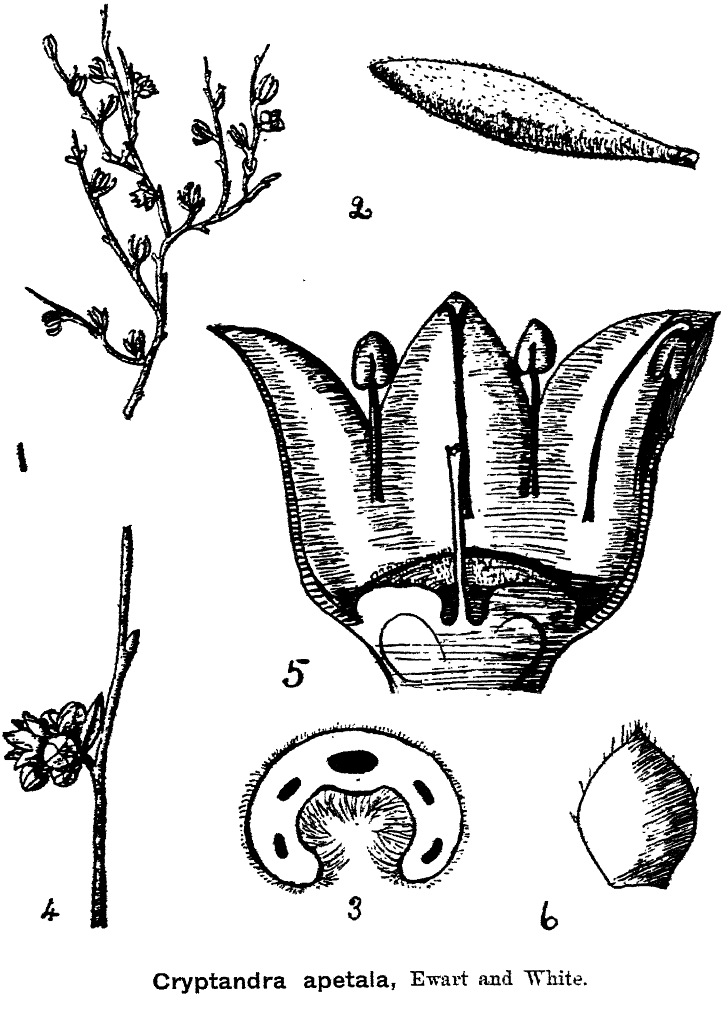
Fig 1 Plant of Drosera Andersoniana Nearly natural size.
2. Peltate cauline leaf Magnified.
3. Flower with petals removed Magnified.
4. Montia fontana, L., var. minor.
(a and b) corolla; (c) calyx (the front segment bent downwards), (d) foliage leaf; (e) fruit surrounded by the persistent calyx lobes, (f) scarious bract, (g) ovary.

Plate XXIII.—Euphorbia Drummondii, Boiss.

Fig. 1. Plant, entire.
2. Portion of vegetative shoot.
3. Flowering leafy shoot.
4, 5, 6. Forms of stipule.

Plate XXIV.—Euphorbia Drummondii, Boiss

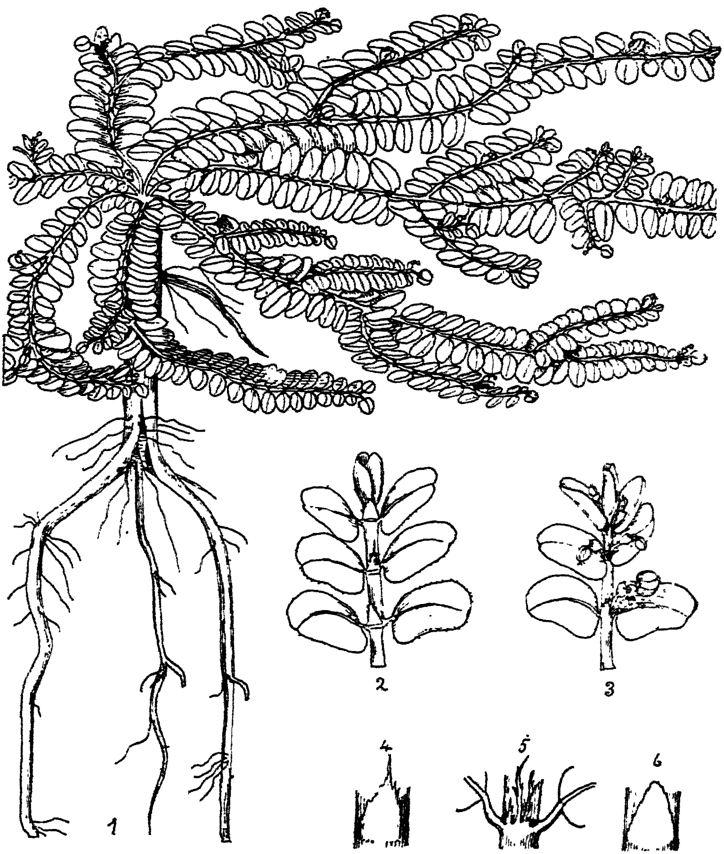
Figs. 1, 2, 3. Front, side, and back views of inflorescence with female and male flowers.
4 Involucre laid open, with only the stalk of the female flower.
5, 6. Male flowers.
7. Pollen grains.



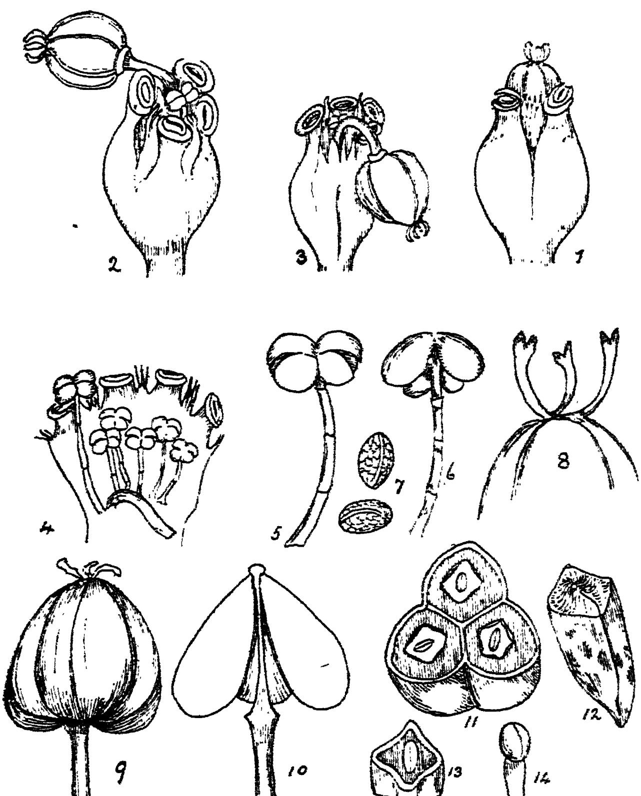
Cryptandra apetala, Ewart and White.

1

Figs. 1–3.—**Drosera Andersonianas**, Ewart and White.
Fig 4.—**Flower of Mantia fontana**, L. var. minor.

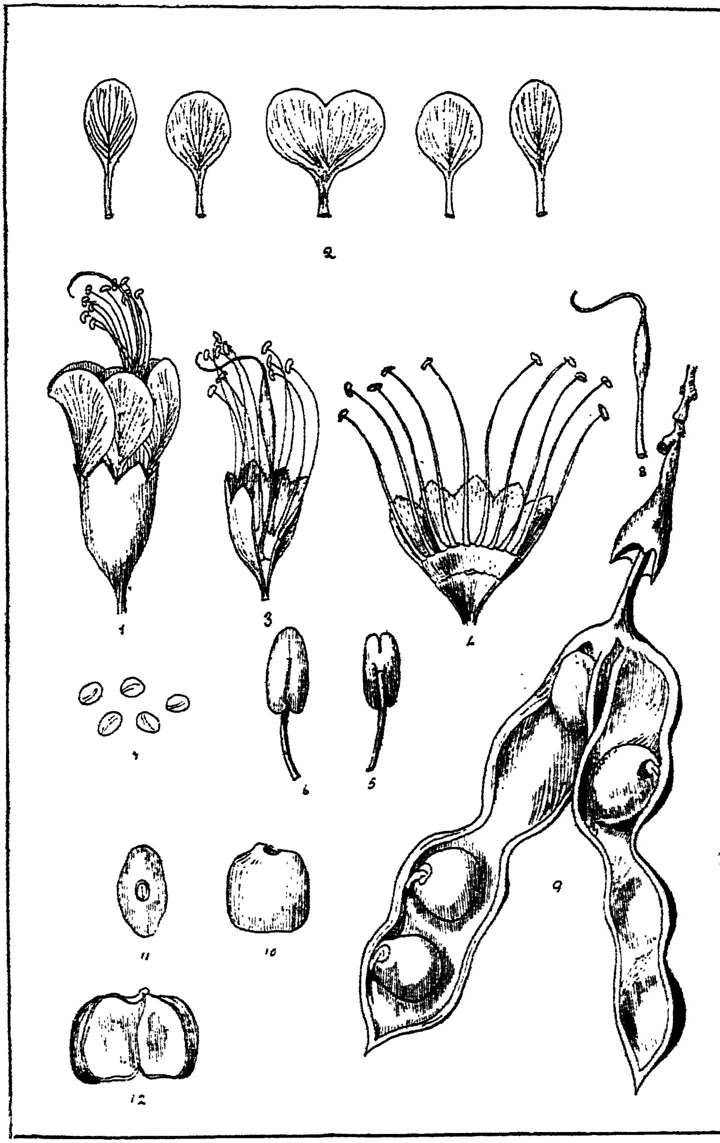


Euphorbia Drummondii, Boiss.



Euphorbia Drummondii, Boiss.

Podopetalum Ormondi, F. v. M.



Podopetalum Ormondi, F. v. M.

8. Styles and stigmas. Enlarged.
9. 10. Ripe and dehiscing fruits.
11. Fruit in section; not yet fully angular.
12. Seed.
13. Section of seed.
14. Embryo.

PLATE XXV.—PODOPETALUM ORMONDI, F. v. M.

Inflorescence and compound leaf.

PLATE XXVI.—PODOPETALUM ORMONDI, F. v. M.

Fig. 1. Flower.
2. Petals.
3. Flower cut open.
4. The same, ovary removed.
5. Stamen from back.
6. Stamen from front.
7. Pollen grains.
8. Ovary.
9. Ripe fruit opened.
10. Seed.
11. Seed shewing hilum.
12. Seed opened.

END OF VOLUME XXII.

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THE AUTHORS OF THE SEVERAL PAPERS ARE SEVERALLY RESPONSIBLE FOR THE SOUNDNESS OF THE OPINIONS GIVEN AND FOR THE ACCURACY OF THE STATEMENTS MADE THEREIN.

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1910.

CONTENTS OF VOLUME XXII., PT. II.

[PROC. ROY. SOC. VICTORIA, 22 (N.S.), PT. II., 1910.]

ART. X.—*New or Little-known Victorian Fossils in the National Museum.*

PART X.—SOME PALAEOZOIC WORMS AND CRUSTACEA.

BY FREDERICK CHAPMAN, A.L.S., &c.,

National Museum.

(With Plates XXVII., XXVIII., XXIX.).

[Read 9th September, 1909.]

Preliminary Remarks.—The present paper relates to a short series of fossils from the Silurian beds in the neighbourhood of Melbourne. The fossils described are the following:—

Trachyderma crassituba, sp. nov.
„ cf. *squamosa*, Phillips.
Turrilepas ornatus, sp. nov.
„ *yeringiae*, sp. nov.
Ceratiocaris pinguis, sp. nov.
„ cf. *pardoeana*, Jones and Woodward.
Xiphidiocaris falcata, sp. nov.

Hitherto, no remains of *Trachyderma* seem to have been recorded from Australia. The genus, however, is well known in the English Ludlow fauna, and has lately been collected from the Silurian of Burma, in beds containing an assemblage of fossils strikingly similar to the Silurian of this State.

Turrilepas has already been described by Mr. Etheridge, junr., from the Bowning beds of New South Wales, and it is therefore of exceptional interest to find their remains in the Victorian Silurian, where they occur in both the Melbournian and Yeringian series.

The commonest genus of the "pod-shrimps," *Ceratiocaris*, is a fairly abundant fossil in the mudstones and shales of South Yarra (exposed in the Yarra Improvement Works), but owing to the irregular fracture and soft texture of the rock it is very

difficult to secure good specimens for description. The numerous carbonaceous nodules and twig-like remains found there are to be generally attributed to that genus; the former representing the internal casts of the carapace, the latter the abdominal segments, the telson and lateral spines.

One of the most important fossils noticed here is *Xiphidiocaris*, a generic type whose species was first described by Salter, and later by Jones and Woodward under the name of *Xiphocaris*. It has hitherto been collected only from the Lower Ludlow beds of England, where it is exceedingly rare. It appears to be related to the ceratiocarids.

(?) Vermes-Errantia.

Genus—*Trachyderma*, Phillips.

This genus was founded to include some more or less problematic fossils which occur in the Ordovician (Caradoc beds) and the Silurian (Woolhope Limestone and Upper Ludlow) in England. In his original description[1] John Phillips says: "It may be ranked among Serpulidae, having a membranous covering, and a remarkable, though not quite regular, alternation (due, perhaps, to a peculiar spirality) of the successive laminae of growth. There are, however, some appearances in the specimens of *T. coriacea*, which may possibly be adduced in favour of a reference of this fossil to a different group of Annelida."

Good examples, referable to the above genus, occur very frequently in the sandy mudstones of the Melbournian division of the Silurian, particularly near Melbourne, and also sparingly in the mudstones of later Yeringian age in the Upper Yarra district. The additional evidence of structure and habit furnished by some of the specimens now described, shows that the tubular lining or strengthening secretion of the walls of the burrow may have been, in at least one of the Australian species, partially calcified, or possibly of the nature of a mud tube similar to that made by the polynoids of the present day. The

1 Mem. Geol. Surv. Gt. Brit., vol. ii., pt. i., 1848, p. 331.

majority of the Victorian fossils of the above genus belong to a type characterised by a tubular covering thicker than that in the English examples, in which the tubes were typically membranous and thin. That these fossils may with good reason be regarded as the crypts of burrowing worms, is shown by the form and disposition of the tubes in the surrounding matrix, which, with their solid infillings, traverse the bedding planes at all angles, but are usually inclined from 20-45 deg. Several specimens have been collected by Mr. Spry which show a vertical direction of the tube at the commencement, but soon after change to the oblique position, and continue meandering for some distance; the longest specimen found, up to the present, measuring a little more than 10 cm. This habit of passing downwards through layers of the soft black or grey mud (shale), suggests an affinity with the burrows of such of the polychaetes which secrete a parchment-like tube. Any reference to the sedentary worms, like the Serpulidae, as suggested by Phillips, is untenable, since the buried tip or termination is completely and evenly rounded, as shown in Plate XXIX., Fig. 1; whilst the sides of the tubes are often irregularly and quite suddenly constricted, instead of gently tapering, as in most so-called sedentary forms.

Trachyderma crassituba, sp. nov.

(Pl. XXVII., Figs. 1a, 1b, 2, 3, ?(4); Pl. XXIX., Fig. 1).

Description.—Tube comparatively thick. Near the entrance, the burrow is usually quite cylindrical, but becomes elliptical in section in its oblique course through the shaley mudstone; long and slightly tapering, with rounded extremity. Externally the tube is marked with coarse corrugations or annuli. Internal surface of tube and casts of the interior are closely ornamented with annulate striae, sometimes disposed obliquely and often imbricated. Sides of tube bulging at intervals; occasionally the whole tube is arcuately bent. Interior of tube filled with a solid core of hard mud, frequently arenaceous, and stained with carbonaceous or organic matter.

Dimensions.—Length of tube in the holotype, cir. 100 mm.; width, 16 mm.; thickness of tube, cir. 4 mm.

Occurrence.—Abundant in the Silurian (Melbournian) of the Yarra Improvement Works, South Yarra. Coll. by F. P. Spry and the writer.

Affinities.—*T. crassituba* seems most nearly allied with *T. squamosa*, Phillips,[1] but differs in the thicker and consequently more rigid tube. The English specimens of *T. squamosa* were found at two different horizons in the Silurian, viz., the Woolhope Limestone and the Upper Ludlow beds.[2]

Remarks.—Many less perfect specimens of *Trachyderma* have been found at South Yarra, which, although apparently referable to *T. crassituba*, show only a stain around the core, as if the wall of the tube had been dissolved away (see Fig. 4). In others the tube is still existent, but nearly of the same substance as the surrounding shale, although of harder texture, so that a fracture in the right direction reveals its tubular nature. The cores or infillings of the burrows show a tendency to crack into short joints, owing to differential shrinkage. It is evident that the departure from the circular section in the contour of the tube is due to pressure of the superposed layers of hardened mud, for the nearer the burrow to the horizontal position, the more compressed does it tend to become. This points to the inevitable conclusion that the tube, however thick it may have been, was always more or less membranous and compressible.

Trachyderma cf. squamosa, Phillips.

(Pl. XXVII., Fig. 5).

T. squamosa, Phillips, 1848, Mem. Geol. Surv. Gt. Brit., vol. ii., pt. 1, p. 332, pl. iv. figs. 3, 4.

Remarks.—An example of *Trachyderma*, which does not show the thick tube of the Melbournian specimens, occurs at another horizon, the Yeringian. In this specimen there are some traces of the plaits and fine striae of Phillips' species, so that we may provisionally refer it to that form. The tube passes at an oblique angle into the shale bed, and is elliptical in section.

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1 Mem. Geol. Surv. Gt. Brit., vol. ii., pt. i., 1848, p. 332, pl. iv., figs. 3, 4.
2 Fossils of the British Islands, Etheridge, R., vol. i., Palaeozoic, 1888, p. 37.

The specimen here figured measures 27 mm. in length, and its greatest width is 6 mm.

It is of much interest to note that Mr. Cowper Reed has already identified a form of *Trachyderma*, which he provisionally refers to the above species, in the Silurian (Zebingyi Beds) of Burma.[1]

Occurrence.—Silurian (Yeringian). In olive brown mudstone, Geol. Surv., Vic. coll. B23, at junction of the Woori Yallock and Yarra. Also a doubtful specimen, in grey shale, of the same series from View Hill Creek, near Yering; Geol. Surv. Vict., coll. B14.

Class, Crustacea. Super-order, Cirripedia.

Turrilepas, H Woodward.

Turrilepas ornatus, sp. nov.

(Pl. XXVIII., Fig. 1; Pl. XXIX., Fig. 2).

Description.—The characters of this species are based on two plates from different localities, in the same division of the Silurian. That selected as the holotype is a single lateral or kite-shaped plate, not quite perfect in outline, but sufficiently so to enable a comparison to be made with the other described forms, and especially with *T. mitchelli*, Eth. fil.,[2] from Bowning, N.S. Wales. This plate is preserved in a grey mudstone, and a ferruginous stain brings out the details of the surface ornament. The outline of the plate is ovate or leaf-shaped, and pointed at the apex, but the point is not so extended as in *T. scotica*, Eth. fil.,[3] a difference also remarked by Mr. Etheridge in the case of the Bowning specimen.[4] The line of the central fold is marked by a strong rounded keel, which

1 Mem. Geol. Surv. India, Pal. Ind., N.S. vol. ii., Mem. 3, 1906, p. 129, pl. vii., fig. 17.

2 Etheridge, R., jnr., "On the occurrence of the Genus Turrilepas, H. Woodw., and Annelid Jaws in the Upper Silurian (? Wenlock) Rocks of New South Wales." Geol. Mag., N.S., dec. iii., vol. vii., 1890, p. 338, pl. xi., figs. 1, 2, 4, 5.

3 Silurian Fossils of the Girvan District, vol. i., 1880, p. 214, pl. xiv., figs. 22-27 (cf., figs. 22-24).

4 Op. supra cit., p. 338.

proves that the internal surface of the plate is exposed.[1] The lateral, imbricating lamellae cross the plate from keel to margin in a wide sigmoidal curve, excepting near the marginal border, where they turn, with a sharp curve, towards the apex. Traces of fine, interrupted, radial striae cross the lamellar surfaces. This feature constitutes a distinctive character from that of *T. mitchelli.*

Dimensions of Holotype.—Length, 5.75 mm.; greatest breadth, 3.83 mm.

The second example of this species, here taken as a paratype, may be a median plate since it is of exceptional breadth. It is, however, of comparatively large size as compared with the median plates of other species. The lamellar ornament is well marked and the lateral upturned edges are seen to be distinctly undulate, especially on the convex side of the fold. This plate is exposed on the outer side, and the median fold is broad and distinct. On the concave side of the median fold there is another wide and shallow fold, which is feebly repeated on the opposite side. The radial striae are more distinct in this specimen, and are seen to extend over the area of the upturned portion of the lamellae.

Occurrence.—Type specimen from the grey mudstone of the Yan Yean Reservoir tunnel, near Whittlesea; coll. and presented by Mr. A. J. Shearsby, F.R.M.S. The (?) median plate, from the mudstone of South Yarra; coll. by Mr. F. P. Spry. Silurian (Melbournian).

Turrilepas yeringiae, sp. nov.

(Pl. XXVIII., Fig. 2).

Description.—Remains of five covering plates with their external surfaces exposed, arranged in a short conical group. Two (?)median plates rather shorter than the laterals, and not quite so sharply folded in the median line; in apposition. Lateral or kite-shaped plates more elongate and acuminate;

1 For a description of the relationship of fold and keel, see F. R. C. Reed, "The Structure of Turrilepas peachi and its Allies." Trans. R. Soc. Edin., vol. xlvi., pt. iii., No. 21, 1908, p. 520.

apex curved. Central fold stronger than in the median or triangular plates. In the median area of each lateral half, a minor and broader fold occurs. Imbricating lamellae closely set, sinuous, and somewhat unequally spaced at different parts of the same plate; this, however, may be due to a slight distortion of the surface. The lamellae crossing the plates nearly at right angles and when within the last third towards the margin, turn up sharply towards the apex.

Dimensions.—Length of entire group, 9.5 mm.; breadth, 7 mm. Length of a lateral plate, 7 mm.; breadth at base, cir. 3 mm. Length of median plate, cir. 3.66 mm.; breadth at base, cir. 2.33 mm.

Occurrence.—Silurian (Yeringian); coll. by Geol. Surv. Vict., B16, about 1½ miles below Simmons' Bridge Hut on the Yarra (Upper Yarra Distr.). At another Yeringian locality, B23, G.S.V., at the junction of the Woori Yallock and Yarra, some separate plates of a *Turrilepas* occur. They are not very well preserved, but show a strong median fold like that in the above species.

Remarks.—This form differs from Etheridge's *T. mitchelli*[1] in the greater proportionate length of the plate, in the exceptional width of the median fold seen on the exterior of the plate, and in the sharply upturned outer edges of the lamellae. In outline, our species bears a marked resemblance to T. scotica, Eth. fil.,[2] but the plates in that species are wider at the base, and more extended and pointed at the apex.

Order—PHYLLOCARIDA (Pod-shrimps).

Genus—*Ceratiocaris*, McCoy.

Ceratiocaris pinguis, sp. nov.

(Pl. XXVIII. Figs. 3-5).

Description of Holotype.—Carapace subovate, sides very tumid. Anterior margin straight, sloping downwards and back-

1 Op. supra cit., p. 338.

2 Mon. Sil. Foss. Girvan, 1880, pl. xiv. figs. 22-24

wards to meet the gently sinuous ventral margin at a moderately wide angle; dorsal border widely curved and sloping rapidly towards the back to meet the short posterior margin; the latter nearly straight or slightly concave, and sharply angled above and below.

Description of Young Forms.—These are more regularly ovoid, with stronger dorsal and ventral curvatures, and absence of angulation at the extremities. One of the examples shows the existence of a moderately broad ventral flange.

Dimensions of Holotype.—Length of carapace, 23.5 mm.; greatest height, 13 mm.; length of exposed abdominal series of segments, 11 mm. Average length of abdominal segments, cir. 3 mm.

Silurian (Melbournian). South Yarra; in mudstone. Found by Mr. P. Taverner.

Affinities.—This is a peculiar form of the genus on account of the inflated appearance of the carapace, and the highly curved dorsal line. There seems to be no very closely related form to this, the nearest being *Ceratiocaris cassioides*, T. R. Jones and H. Woodward,[1] a species found in the Lower Ludlow of Leintwardine, Shropshire, associated with small brachiopods and *Cardiola cornucopiae.*

Remarks.—Examples of the present species are very numerous in the grey and brown mudstone of South Yarra (Yarra Improvement Works), but are nearly all indifferently preserved. It was apparently gregarious in habit, since one slab of mudstone showed traces of nearly a score of individuals crowded together. The general appearance of the specimens is that of a swollen subovate carapace-cast, which is almost invariably stained with carbonaceous material. In the type-specimen there is a circular elevation of the matrix on the upper anterior area of the carapace, suggestive of an ocular spot; but since several of the earlier described so-called ocular-bearing phyllocarids, owing to illusionary cavities and fragments of matrix, have now turned out to be really referable to *Ceratiocaris*, it necessitates great care in their interpretation. Should an

1 Mon. Brit. Palaeozoic Phyllopoda, Pal. Soc., 1888, p. 59, pl. iii., fig. 9; pl. iv., fig. 7 pl. vii., figs. 4-6.

ocular spot be demonstrable in this form it would require to be removed to the genus *Emmelozoe;* but this genus, by the way, has hitherto furnished no evidence of appendages to the carapace.

CERATIOCARIS cf. PARDOEANA, J. and W. (Plate XXVIII., fig. 6).

C. ("*pardoensis*") *pardoeana*, La Touche (nom. emend. T.R.J. and H.W.), Jones and Woodward, 1888, Mon. Brit. Pal. Phyll., pt. i., p. 30, pl. v., figs. 1, 2.

Description.—An imperfect example of a carapace, wanting the anterior region, and with two abdominal segments, occurs in the mudstone of South Yarra. It is closely allied to the above species, if not identical with it. The dorsal margin is nearly straight, with not quite the decided curvature of *C. pardoeana;* the ventral margin is truncated anteriorly, and sharply rounded posteriorly. There is a large amount of variation in the English examples of *C. pardoeana* from the Lower Ludlow, which helps to make our comparison better founded. The two abdominal segments, as in *C. pardoeana*, are broad and short.

Dimensions.—Approximate length of carapace when complete, 28 mm. Greatest height, 19 mm. Height of first abdominal segment, cir. 14 mm.; length, 5 mm.

Occurrence.—Silurian (Melbournian). In bluish mudstone; South Yarra. Coll. by F. P. Spry.

Genus—*Xiphidiocaris*, J. M. Clarke.

Note.—The phyllocarid genus *Xiphocaris* was published by Prof. Rupert Jones and Dr. H. Woodward in 1886. The name was preoccupied, however, by a genus of the *Palaemonidae* (prawns), published by Martens in 1872. In Zittel's Text Book of Palaeontology (Engl., ed. by Eastman, 1900), at p. 655, Prof. J. M. Clarke makes the following reference:—"*Xiphidiocaris*, Jones and Woodw. (emend.)." The altered name must therefore stand as above.

Xiphidiocaris falcata, sp. nov.

(Pl. XXVIII., Figs. 7, *7a-d*).

Description.—Telson slender, incurved, widely sickle-shaped, gradually tapering from the broad, flattened proximal end to the bluntly-pointed distal extremity. Edges nearly smooth; a few remnants of small spines present on the concave or inner border. Surface (side) bearing a subcentral ridge. at first flat at proximal end, contracting to a strong ridge passing obliquely towards the outer border, where it persists to the apex. So far as can be seen, the surface was relieved by an imbricated, scaly ornament near the base, whilst the distal surface bore series of pittings parallel with the inner side. Surface also marked with fine longitudinal striae, especially on the outer side of the ridge of the convex border, where they become oblique. In cross section the form would be subrhomboidal, with flattened sides and broad grooves along the outer and inner borders.

Dimensions.—Length of telson, 58 mm.; width at proximal end, 9 mm.; width at 20 mm from base, 5 mm.; width at 50 mm. from base, 2.25 mm.

Occurrence.—Silurian (Melbournian). In the blue mudstone of South Yarra. Coll. F. P. Spry.

Remarks.—The originally described examples of this genus were found in the Lower Ludlow of Shropshire. The only species hitherto known is *X. ensis*, Salter sp.,[1] a form distinguished from ours by the wider curvature of the telson, the more regularly ovate section, and the conspicuous and regular serration of the edges. The surface pits visible in the English examples are interpreted by Messrs. Jones and Woodward as the bases of spines; a character also seen in the telsons of *Ceratiocaris*, to which genus this imperfectly understood form seems allied.

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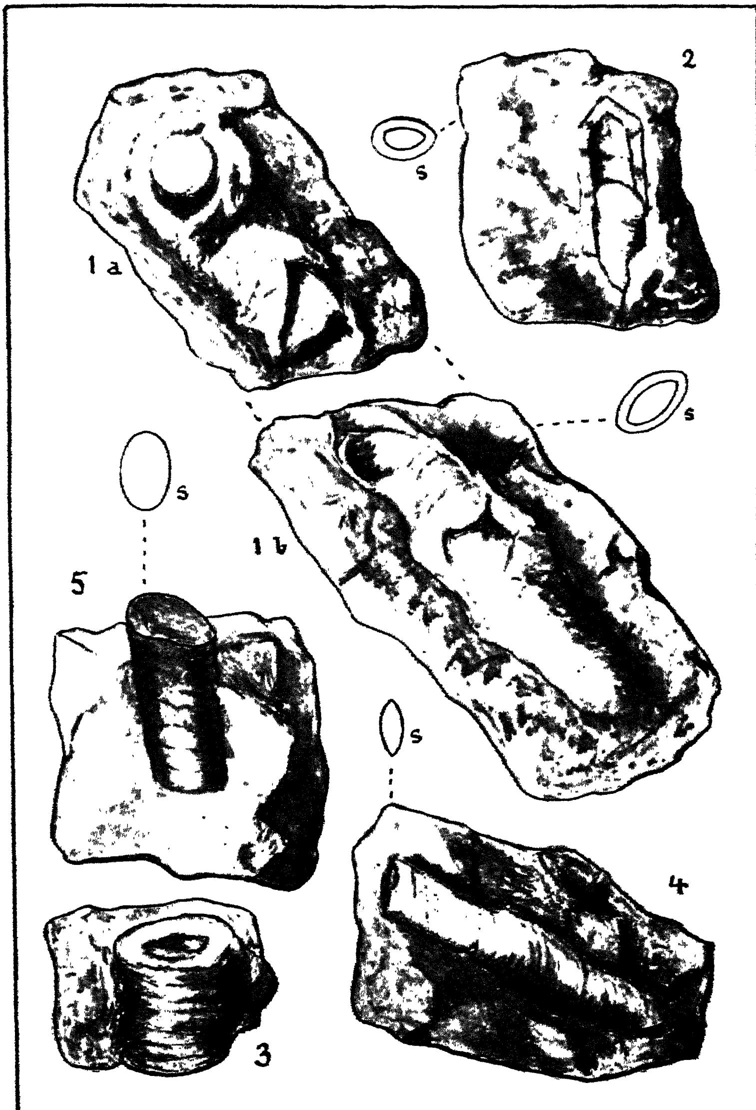
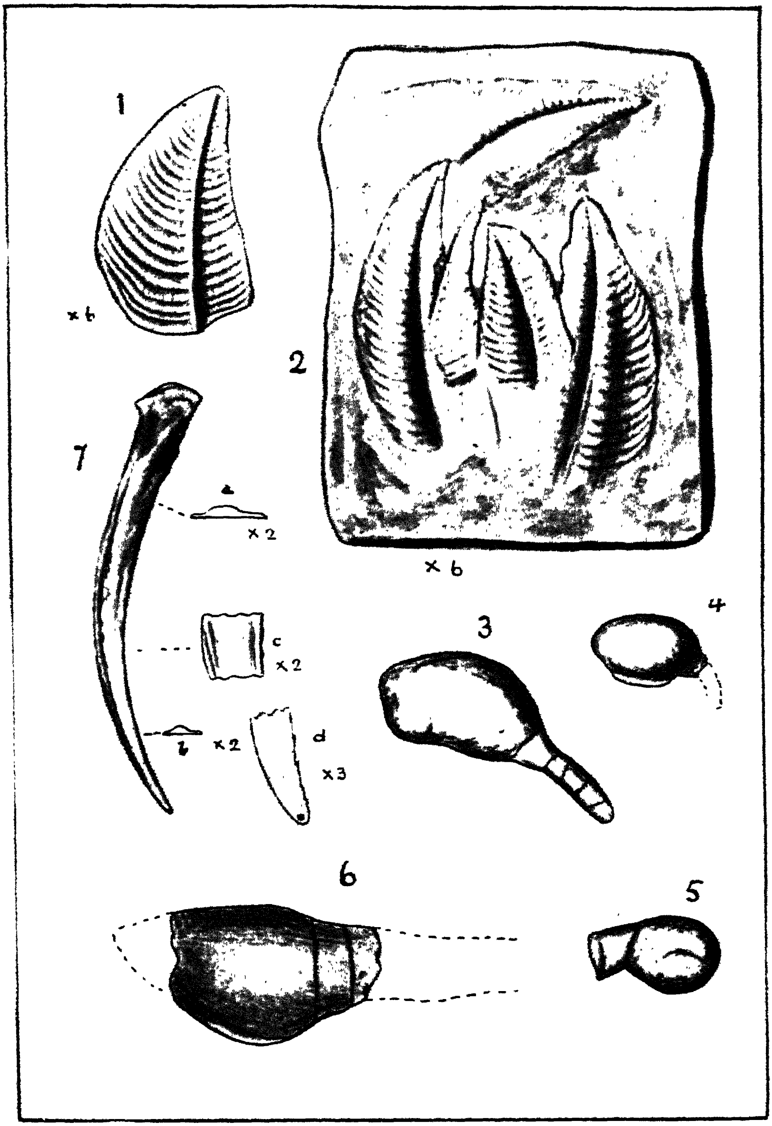
1 See *Xiphocaris ensis*, Salter sp. Jones and Woodward, Mon. Brit Pal. Phyllopoda, Pal. Soc., 1888, p. 62, pl. v., figs. 7a-d



F. C. del.

Trachyderma (Worm burrows), Silurian: Victoria.



F. C. del.

Turrilepas and Phyllocarids, Silurian: Victoria.

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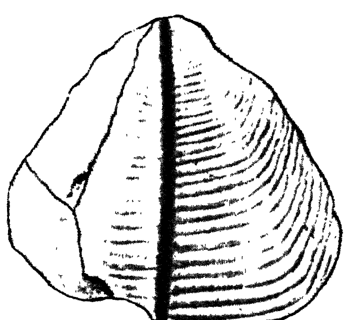

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F. C. del.

Trachyderma and Turrilepas, Silurian: Victoria.

EXPLANATION OF PLATES.

Plate XXVII.

Fig. 1a,b.—Tube and cast of burrow of *Trachyderma crassituba*, sp. nov: 1*a*, upper portion showing the circular contour of the burrow where vertical to the bedding; 1*b*, continuation of same burrow, less part of specimen at gap, showing, by section(s) the compressed outline where nearly horizontal with plane of bedding. 1*b* is turned through 180 deg. to show the burrow on the same plane as 1*a*, but which is in reality on the relatively opposite face in regard to 1*a*, the slab having been fractured through to the underside of the specimen. Holotype. Silurian (Melbournian). S. Yarra. Coll. by F. P. Spry. Nat. size.

Fig. 2.—*T. crassituba*, sp. nov., in hard dark grey mudstone. Paratype. Silurian (Melbournian). Between Hoyte's Paddock and Punt Road, South Yarra. Coll. by F. P. Spry. Nat. size.

Fig. 3.—*T. crassituba*, sp nov A specimen showing the outer, corrugated surface of the tube. Paratype. Silurian (Melbournian). S. Yarra. Coll. by F. P. Spry. Nat. size.

Fig. 4.—*Trachyderma* cf. *crassituba*, sp. nov. Specimen oblique to plane of bedding, showing cast only. Silurian (Melbournian). S. Yarra; between Hoyte's Paddock and Punt Road. Coll. by F. P. Spry. Nat. size.

Fig. 5.—*Trachyderma* cf *squamosa*, Phillips. Cast of burrow, oblique to the bedding plane. Silurian (Yeringian). Junction of Woori Yallock and Yarra. Coll. Geol. Surv. Vict. B23.

N.B.—All figures on this plate of the natural size. *s* = transverse section.

Plate XXVIII.

Fig. 1.—*Turrilepas ornatus*, sp. nov. Holotype. Inner surface of plate. Silurian (Melbournian). Yan Yean. Coll. by A. J. Shearsby. × 6.

Fig. 2.—*Turrilepas yeringiae*, sp. nov. Holotype. Portion of individual, comprising five plates; outer surface exposed. Silurian (Yeringian). Junction of Woori Yallock and Yarra. Coll. Geol. Surv. Vict. × 6.

Fig. 3.—*Ceratiocaris pinguis*, sp. nov. Holotype. Cast of carapace and five abdominal segments. Silurian (Melbournian). S. Yarra. Coll. by P. Taverner. Nat. size.

Fig. 4.—*C. pinguis*, sp. nov. Cast of carapace and part of abdominal segment of an immature specimen, having a more ovoid body and vestige of a ventral flange. Silurian (Melbournian). S. Yarra. Coll. by P. Taverner. Nat. size.

Fig. 5.—*C. pinguis*, sp. nov. Cast of carapace and abdominal segment of a young, rotund-shaped individual. Silurian (Melbournian). S. Yarra. Coll. by P. Taverner. Nat. size.

Fig. 6.—*Ceratiocaris* cf. *pardoeana*, Jones and Woodward. Portion of carapace and two abdominal segments. Silurian (Melbournian). S. Yarra. Coll. by F. P. Spry. Nat. size.

Fig. 7a-d.—*Xiphidiocaris falcata*, sp. nov. Telson. Nat. size. *a*, *b*, sections showing superficial contour at two places, × 2; *c*, surface enlarged, × 2; *d*, outline at apex, showing serrated concave margin and an apical pit, × 3. Silurian (Melbournian). S. Yarra. Coll. by F. P. Spry.

Plate XXIX.

Fig. 1.—Cast of worm burrow of *Trachyderma crassituba*, sp. nov., showing the rounded base. (A mould of *Nuculites maccoyianus* on the same slab). In mudstone. Silurian (Melbournian). S. Yarra. Coll. by F. P. Spry. Two-thirds nat. size.

Fig. 2.—*Turrilepas ornatus*, sp. nov. External surface of (?) median plate. Silurian (Melbournian). S. Yarra. Coll. by F. P. Spry. × 6.

[Proc. Roy. Soc. Victoria, 22 (N.S.), Pt. II., 1909.]

Art. XI.—*On Australian and Tasmanian Coleoptera, with Descriptions of New Species. Part I.*

By ARTHUR M. LEA.

(With Plate XXX).

[Read 9th September, 1909].

In Masters' Catalogue of Australian Coleoptera 7201 species of beetles are listed. Since then about 6000 additional species have been described or recorded; but probably considerably over 10,000 species remain to be treated.

The large and showy species have been comparatively well worked out, at any rate from the more settled districts. But the desert portions of Australia, containing in favourable seasons many large and handsome species, have been hardly touched for insects. Many extremely rich parts of Queensland have never been systematically collected in, or even traversed by collectors. The Northern Territory and N.W. Australia, except for a slight fringe of coastal country, have been practically untouched.

When we come to the families of small and obscure species, however, it is no unusual circumstance for an entomologist to find that in his collection is a greater number of species than is recorded for the entire family he may be working at. And at least two collections in Australia (the Macleay Museum and my own) contain more species than are recorded for the whole of the continent.

The nests of ants, bees and termites, on careful examination, yield many singular forms of beetles; but probably less than a dozen entomologists have systematically examined such nests in Australia.

Species are numerous at the roots of beach-growing plants, but not one has been recorded from the whole of the tropical portions of Australia, except a few from the north-west.

Mosses and lichens are extraordinarily productive of beetles, of small size mostly, but many of great beauty or singular form. And yet most collectors never even cursorily examine moss, let alone tear it to pieces or sieve it over white paper.

Tussocks of grasses and sedges are also very productive in autumn and winter, and are usually neglected by collectors. As are also fallen leaves in forests.

Of our common trees the casuarinas produce many species that are found on no others; the genus *Misophrice*, for instance, is practically confined to them. Several entomologists have carefully searched for species of this genus in N.S. Wales, S. and W. Australia, and Tasmania, with the result that numerous species have been recorded from those States. But from north of the 29th deg. apparently not a single species has been taken; and yet it is probable that in the northern parts of the continent they are at least as numerous as in the southern.

In New Zealand many beetles are to be obtained in the dead fronds of the larger ferns; but this source has been practically untouched in Australia.

Breeding, except for a few species of economic importance, is also a neglected source of specimens. A few grubby sticks of even our common wattle and gum trees will often yield beetles in abundance that are seldom or never found in the open. Even such highly important timber-destroying species as the *Scolytidae* have been neglected; plain proof of this being the description or record, in the present paper, of a greater number of species than all hitherto recorded from Australia.

Of other families that have been more or less neglected there may be mentioned *Hydrophilidae, Staphylinidae, Pselaphidae, Scydmaenidae, Silphidae, Trichopterygidae, Phalacridae, Cryptophagidae, Dermestidae, Elateridae, Dascillidae, Ptinidae, Cistelidae, Melandryidae, Anthicidae* and *Corylophidae*; and several sub-families of *Chrysomelidae* and *Curculionidae*. And it may be taken for granted that any entomologist desirous of describing new species would be certain of finding such species in even a small collection of any of the families mentioned, whilst new species are far from being exhausted even in such showy groups as the *Cicindelidae, Buprestidae, Cerambycidae* and *Cetonides*.

STAPHYLINIDAE.

Calodera tenuicornis, n. sp.

Reddish-testaceous, elytra and abdomen somewhat darker, base of abdomen paler than apex, tibiae darker than femora or tarsi, antennae infuscate except at base and apex. Moderately densely clothed with short greyish pubescence, sparser and longer on abdomen than elsewhere; sides of abdomen with moderately long brownish hairs.

Head densely and finely punctate. Antennae rather long, first joint almost as long as second and third combined, second distinctly longer than third, the others decreasing in length to tenth, but none transverse, eleventh almost as long as ninth and tenth combined. *Prothorax* about twice as wide as long, base and sides rounded, base considerably wider than apex; punctures rather sparse and very small. *Elytra* about as long as head and prothorax combined, at base wider than the latter, the width increasing to apex, each inwardly oblique to suture at apex; densely and rather finely punctate. *Abdomen* almost parallel-sided to apical segment; rather sparsely and irregularly punctate. Length $3\frac{1}{4}$, to apex of elytra $1\frac{1}{2}$ mm.

Hab.—N.S. Wales: Dalmorton.

In outline somewhat like *inaequalis*. but the punctures very much finer and the joints of the antennae differently proportioned.

Calodera marginicollis, n. sp.

Reddish-testaceous, middle of antennae slightly darker, apical half of elytra (except the apical angles) and the fifth abdominal segment piceous; metasternum slightly infuscate. Moderately clothed with rather short yellowish pubescence, longer and sparser on abdomen than elsewhere.

Head subopaque, indistinctly punctate. Antennae stout, first joint almost as long as second and third combined, these two subequal in length, third feebly, fourth to tenth strongly transverse, eleventh briefly subconical. *Prothorax* about once and one-third wider than long, base and apex almost equal, sides rounded, but towards base directed slightly outwards, the pos-

terior angles almost right angles; densely and moderately coarsely punctate, with a shallow but distinct median line. *Elytra* wider than prothorax and about once and one-half as long, not much wider at apex than at base, each separately rounded at apex; punctures rather coarser and sparser than on prothorax. *Abdomen* almost parallel-sided to apical segment; densely coarsely and irregularly punctate, four basal segments each with a deep transverse sulcus at base. Length 2¼, to apex of elytra 1 mm.

Hab.—W. Australia: Bridgetown.

A specimen from Karridale differs in being considerably paler, with a patch at the outer apex of each elytron, and the fifth abdominal segment rather lightly infuscate. The species appears somewhat out of place in *Calodera*, but it is certainly congeneric with *eritima.*

Calodera rufipennis, n. sp.

Red; head, abdomen (except apical half of the subapical and the whole of the apical segments) meso and metasternum piceous or black; antennae piceous, three (or four) basal joints paler; femora slightly infuscate. Moderately clothed with rather short yellowish pubescence, sparser on metasternum and upper surface of abdomen than elsewhere.

Head (for the genus) rather coarsely punctate; joints of antennae as in the preceding species, except that the fifth to tenth are decidedly more transverse. *Prothorax* about once and one-half as wide as long, base and sides rounded, base not much wider than apex; punctures evenly distributed and rather coarse. *Elytra* slightly wider and (along suture) not much longer than prothorax, apex not much wider than base, each separately rounded at apex; punctures coarser than on prothorax. *Abdomen* almost parallel-sided to apical segment; moderately coarsely and somewhat irregularly punctate; four basal segments with a strong transverse impression at base. Length 2¼, to apex of elytra 1 mm.

Hab.—W. Australia: Pinjarrah.

In general appearance somewhat like a small *Aleochara.*

Calodera alternans, n. sp.

Bright-red; head sometimes slightly darker than prothorax, elytra (usually obscurely diluted with red along suture and apex) and four apical segments of abdomen piceous or black; legs testaceous, antennae reddish-brown, the basal joints paler. Rather sparsely clothed with greyish-yellow pubescence, sides with moderately long hairs.

Head with distinct but rather sparse and small punctures. Antennae moderately long; first joint not much longer than second, second and third subequal, fourth and fifth feebly, sixth to tenth more distinctly transverse, eleventh as long as the two preceding combined. *Prothorax* about once and one-half as long as wide, base moderately, the sides more noticeably rounded, base scarcely wider than apex; disc with a large shallow impression towards base; with moderately large but not very regularly distributed punctures. *Elytra* distinctly wider than, and about once and one-third the width of prothorax, sides parallel, each feebly separately rounded at apex; punctures coarser than on prothorax, and almost regular. *Abdomen* parallel-sided to apical segment, with strong punctures only in a distinct transverse impression at the base of each segment. Length $3\frac{1}{4}$, to apex of elytra $1\frac{1}{2}$ mm.

Hab.—W. Australia: Bridgetown, Swan River.

In the (four) specimens under examination the prothorax appears to be flattened or very slightly excavated for about a third of its width from the base, but much less towards the apex, the part affected being almost pear-shaped.

Calodera microps, n.sp.

Testaceous-red, legs paler, abdomen piceous except the apical third of the three basal segments, extreme apex of the fourth, apical half of the sixth and the whole of the seventh; antennae piceous-brown, the basal joints (and the apical to a slight extent) paler; base of metasternum clouded with brown. Rather sparsely clothed with moderately short golden pubescence.

Head longer than wide, with rather small and sparse punctures. Antennae as in the preceding species, except that the

eleventh joint is distinctly longer than the two preceding combined. *Prothorax* rather more convex than usual, sides rounded, base scarcely, if at all, wider than apex; densely and moderately strongly punctate, with a shallow transverse impression in the middle of the base. *Elytra* wider than, and about once and one-fourth the length of prothorax, shoulders rounded, sides parallel behind them, each feebly separately rounded at apex; densely and coarsely punctate, the punctures much smaller posteriorly. *Abdomen* parallel-sided to apical segment, with coarse punctures only in a distinct transverse impression at the base of each segment. Length 3 (vix), to apex of elytra 1¼ mm.

Hab.—Victoria: Emerald.

A small narrow species not very close to any with which I am acquainted; it should perhaps be placed near *inaequalis*. The eyes are smaller and much less prominent than is usual in the genus.

Calodera inaequalis, Fvl.

A specimen from Bunbury (W.A.) under examination appears to represent a variety of this species (I have typical specimens from New South Wales and Tasmania). It differs from the normal form in being smaller, narrower and paler, the median line on the prothorax scarcely pronounced (except at base), with the punctures everywhere sparser and much smaller.

Calodera extima, Oll.

A specimen from Benalla (Victoria) agrees exactly with the description of this species; two others from Albury (N.S. Wales) differ in having a distinct spot on each side of the elytra, in addition to the basal one; another from Hobart (Tasmania) has the lateral spots also, but they are obscurely connected with the basal one. The specimens from Albury and Hobart also have the fourth abdominal segment almost as dark as the fifth.

Conosoma baricephalum, n. sp.

Shining. Reddish-testaceous, appendages paler; suture narrowly infuscate. Clothed with short golden pubescence, longer on abdomen than elsewhere; a rather long black hair on each

side of apex of elytra and of each of the abdominal segments; the two apical segments, however, with numerous hairs.

Antennae comparatively short.[1] *Prothorax* large, strongly convex, moderately transverse, closely enveloping the head, posterior angles rounded but produced and enveloping the elytra; indistinctly punctate. *Elytra* narrower than prothorax at base and much narrower at apex, posterior angles strongly rounded, shorter along suture than towards sides, rapidly diminishing in vertical height from base to apex, sides just perceptibly projecting outwards and downwards: densely and finely punctate. Length 3, to apex of elytra $1\frac{1}{3}$ mm.

Hab.—W. Australia: Bridgetown.

A very distinct species, appearing top-heavy from the unusually large and convex prothorax and peculiar elytra; the punctures and pubescence of the latter are very sparse in the vicinity of the scutellum. Numerous specimens were seen in the nest of a species of "sugar" ant under a stone.

Conosoma myrmecophilum. n. sp.

♂. Moderately shining. Dull reddish-testaceous, appendages paler: base of prothorax, apex of elytra and middle of abdomen slightly infuscate. Densely clothed with short and somewhat golden pubescence, longer on abdomen than elsewhere; front of head, sides of prothorax, elytra and abdomen with long brownish or blackish hairs, denser on abdomen than elsewhere.

Antennae rather stout, fifth to tenth joints transverse, eleventh almost as long as three preceding combined. *Prothorax* decidedly transverse, base gently emarginate throughout; indistinctly punctate. *Elytra* comparatively large, outline continuous with that of prothorax, and not much wider at base than at apex, slightly longer than prothorax; apex truncate, the posterior angles very slightly rounded; sides slightly flattened out but not upturned; with dense subasperate punctures. Subapical segment of *abdomen* deeply triangularly excised. Length 3, to apex of elytra $1\frac{1}{3}$ mm.

Hab.—W. Australia: Swan River.

1 Although I have now four specimens, I have not been able to place the antennae of any of them in a satisfactory position for close examination.

Although at a glance this species has a very commonplace appearance, it is not very close to any with which I am acquainted, and the long terminal joint of the antennae should render it easy of recognition. The long hairs on the head and prothorax are scarcely half the length of those on the elytra and abdomen, and are visible with difficulty from certain directions. The unique specimen under examination was taken from an ants' nest.

Consoma bipartitum, n. sp.

♀. Shining. Testaceous-red, head (muzzle excepted) glossy black; metasternum and abdomen infuscate, two apical segments and the apex of each of the others paler; legs and antennae reddish-testaceous, base of antennae and the palpi paler. Clothed with short golden pubescence, longer on abdomen than elsewhere; sides of the latter with long brownish or blackish hairs, becoming rather numerous on the two apical segments.

Antennae rather long; sixth to tenth joints transverse, eleventh scarcely as long as two preceding combined. *Prothorax* strongly transverse, base truncate; with sparse and indistinct punctures. *Elytra* slightly narrower and slightly longer than prothorax, the sides slightly upturned and diminishing in width from shoulders to apex, shortest along suture, posterior angles scarcely rounded; with moderately dense, subasperate punctures. Length $3\frac{1}{4}$, to apex of elytra $1\frac{1}{3}$ mm.

Hab.—Victoria: Emerald.

A rather depressed species somewhat resembling *triangulum*, but flatter, the elytra differently coloured and the antennae different, the six terminal joints being considerably flatter than is usual; in general appearance it closely resembles *sextum*, but besides being rather narrower it may be at once distinguished from that species by its parti-coloured head.

Conosoma orthodoxum, n. sp.

♀. Shining. Dark reddish-testaceous; head (muzzle excepted) almost black; elytra, sterna and abdomen clouded with piceous, the apical segments and the apex of each of the others paler; legs clear reddish-testaceous; antennae infuscate, their

basal joints and the palpi considerably paler. Clothed with short golden pubescence, longer and somewhat sparser on the apical half of each of the abdominal segments than elsewhere; apical segments with long blackish hair.

Antennae moderately long, sixth to tenth joints transverse, eleventh decidedly shorter than the two preceding combined. *Prothorax* moderately transverse, base almost truncate; indistinctly punctate. *Elytra* slightly narrower and slightly longer than prothorax, slightly shorter along suture than towards sides; sides almost straight, the margins narrowly upturned; posterior angles feebly rounded; rather densely and finely punctate. Length 3¼, to apex of elytra 1½ mm.

Hab.—W. Australia: Karridale.

In appearance somewhat resembling *triangulum*, but narrower, the elytra unicolorous, and the apical segments only with long hairs; from *impenne*, which it resembles in colour, it differs in its much shorter and stouter antennae and longer elytra.

Conosoma tertium, Lea.

This appears to be a variety of *activum* judging from a Tasmanian example of the latter.

Conosoma elongatulum, Macl.

I am inclined to regard this name as a synonym of *fumatum*.

C. australe, Er.

Hab.—Tasmania, Victoria.

C. eximium, Oll.

Hab.—Swan River.

C. nonum, Lea.

Hab.—W.A.: Donnybrook.

Quedius mediofuscus, n. sp.

Reddish-castaneous, head infuscated between eyes. Head and prothorax glabrous except for a few long hairs at the sides;

elsewhere with comparatively long and sparse pubescence, sides and apex of abdomen with long hairs.

Head, including neck, distinctly longer than wide, without it just about as long as wide; upper surface with two setiferous punctures close to each eye, and four close to the neck. Antennae extending to base of prothorax, first joint as long as second and third combined, these subequal in length, the others to the tenth gradually decreasing in length, but only the eighth-tenth distinctly transverse. *Prothorax* with sides and base strongly rounded, with a few marginal setiferous punctures at sides, base and apex, and two simple ones on disc. *Elytra* lightly transverse; with small and comparatively sparse punctures. *Abdomen* with sparse but not very small punctures, becoming small posteriorly, and absent at base of three first segments. Basal joint of middle *tarsi* stout, and with a blackish upper rim. Length 7, to apex of elytra 3 mm.

Hab.—Tasmania: Mount Wellington (A. M. Lea).

In general appearance close to *xylophilus*, but more robust, elytra concolorous with prothorax and abdomen, and with decidedly sparser punctures on both elytra and abdomen. There are two specimens before me, both apparently males.

Lithocharis tenuicornis, n. sp.

Depressed, subopaque. Dull testaceous, legs paler, upper surface of head piceous. Clothed with short greyish pubescence, a few long hairs at the sides and at the apex of abdomen. Densely and finely punctate all over.

Head large. Antennae thin, passing base of prothorax, first joint as long as second and third combined, second almost as long as third and fourth combined, fourth to tenth feebly decreasing in length but none transverse, eleventh thinner and distinctly longer than tenth. *Prothorax* transverse, narrower than head, apex wider than base, anterior angles feebly, the posterior strongly rounded. *Elytra* wider than, and about once and one-third longer than prothorax, sides feebly increasing in width to apex, each slightly rounded and inwardly oblique to suture at apex. *Abdomen* parallel-sided to about middle, thence decreasing rather rapidly in width to apex. Length 2, to apex of elytra 1 mm.

Hab.—N.W. Australia: Upper Ord River (R. Helms).

In general appearance much the same as *tristis*, but the size much smaller, the head considerably larger and the prothorax decidedly transverse.

Lithocharis tristis, Macl.

No part of this insect could fairly be called "black." Its darkest part (the upper surface of the head) is piceous-brown. I have specimens from the Clarence and Hawkesbury Rivers.

Bledius semicircularis, n. sp.

Piceous-black, apex and sides of elytra and appendages flavous, tibiae and terminal joints of antennae slightly infuscate. Clothed with moderately long whitish pubescence, becoming golden on head and abdomen, on the latter longer and sparser than elsewhere.

Head with moderately small and rather sparse punctures, and with dense minute punctures; antennary tubercles prominent and tipped with red. Clypeus with denser punctures than elsewhere, its sutures distinct. Antennae rather long, first joint almost as long as the second to fifth combined, second as long as the third and fourth combined. *Prothorax* moderately transverse, subcordate, base largely and suddenly narrowed, with a narrow and moderately deep continuous median line; with small depressed minutely punctured granules, the interspaces of equal size and equally punctate. *Elytra* wider and about once and one-fourth longer than prothorax, sides parallel, each feebly separately rounded at apex; densely and moderately finely punctate. *Abdomen* feebly dilated from base to beyond middle, each segment very feebly transversely corrugated and sparsely punctate, the margins distinctly punctate; under surface scarcely corrugated, but with dense minute punctures, in addition to the small ones. Length 5, to apex of elytra 3 mm.

Hab.—Queensland: Brisbane (A. J. Coates).

The shape and punctures of the prothorax and colour of the elytra should render this a remarkably distinct species. The prothorax can scarcely be called granulate, though from some directions it appears to be so, the elytral punctures cause a some-

what similar (but much less pronounced) appearance. The darker part of the elytra is semicircularly bounded by the paler, the two colours being very sharply defined; the shoulders, however, are diluted with flavous.

Bledius parvulus, n. sp.

Piceous-brown, elytra red or piceous-red, the legs paler, antennae infuscate, the basal joints paler. Clothed with rather sparse greyish pubescence, rather longer and decidedly sparse on abdomen than elsewhere.

Head rather large; indistinctly punctate; antennary tubercles feeble. Clypeus with indistinct sutures. Antennae moderately long, first joint almost as long as the second to fifth combined, four terminal joints rather stouter than usual. *Prothorax* rather strongly transverse, base largely but not suddenly narrowed; with a narrow and moderately distinct median line; with moderately dense and comparatively small punctures, the interspaces densely and minutely punctate. *Elytra* distinctly wider than and about once and one-half the length of prothorax, sides subparallel to near apex, each feebly separately rounded; densely, strongly and almost regularly punctate. *Abdomen* almost parallel-sided to near apex, scarcely visibly punctate and transversely corrugated. Length 2, to apex of elytra 1 mm.

Hab.—W. Australia: Beverley, Pinjarrah.

In general appearance much resembling *mandibularis*, but not half the size of that species.

B. aterrimus, Fvl.

Hab.—N. S. Wales, W. Australia.

B. phytosinus, Fvl.

Hab.—Sydney, N. S. Wales.

B. mandibularis, Macl.

Hab.—Windsor, Tamworth, N. S. Wales.

B. caroli, Blackb.

Hab.—S. Australia.

B. minax, Blackb.

Hab.—Vasse, W. Australia.

B. insignicornis, Blackb.

Hab.—Victoria.

Sartallus signatus, Sharp.

Hab.—Sydney, N. S. Wales.

Trogophlaeus apicirufus, n. sp.

Very narrow and subopaque. Piceous-black, prothorax and antennae obscure reddish-brown, apex of elytra somewhat paler, legs pale testaceous. Rather sparsely clothed with very short greyish pubescence.

Head densely but very indistinctly punctate, a shallow impression on each side in front, antennary tubercles not prominent. *Prothorax* lightly transverse, subcordate, moderately convex; a feeble impression on each side of middle terminated some distance before apex, and towards base terminated in a very feeble transverse impression; densely and finely punctate. *Elytra* considerably wider than, and about once and one-half the length of prothorax, each inwardly oblique to suture at apex; punctures stronger than on prothorax. *Abdomen* almost parallel-sided to near apex; densely and finely punctate. Length 1⅓, to apex of elytra ⅔ mm.

Hab.—N.S. Wales: Clarence River.

The tip of the elytra is red as in *adelaidae*, but the size is much smaller (Mr. Blackburn gives the length of his smallest specimen of *adelaidae* as 2½ mm.), and the prothorax is differently sculptured.

Trogophlaeus noctivagus, n. sp.

Narrow, depressed, opaque. Black, prothorax and elytra piceous-black; legs piceous, base and apex of tibiae and the tarsi paler, antennae infuscate but paler towards base. Densely clothed with very short, greyish pubescence. Densely and finely punctate throughout.

Head with a very shallow longitudinal impression on each side in front, antennary tubercles feeble. *Prothorax* feebly or not at all transverse, apex distinctly (but not much) wider than base, each side of middle with a feeble longitudinal impression. *Elytra* flat, considerably wider than, and about once and one-half the length of prothorax. *Abdomen* increasing in width from base to near apex. Length 1¼, to apex of elytra ⅔ mm.

Hab.—W. Australia: Swan River, Beverley.

Differs from *exiguus* in having moderately distinct prothoracic impressions; the elytra rather longer and with smaller punctures, the abdomen less parallel-sided and the legs darker. All the (numerous) specimens under examination were obtained at lights. The impressions on the prothorax sometimes appear as two regular longitudinal depressions; they are, however, frequently interrupted, when each appears as two shallow foveae; in two specimens they are conjoined so that a large part of the disc is slightly concave.

Trogophlaeus pictipes, n. sp.

Comparatively wide, depressed, opaque. Of an uniform piceous-black, antennae scarcely paler, base and apex of tibiae and the tarsi testaceous. Densely clothed with short greyish pubescence, becoming moderately long on the sides of prothorax and head and on the sides and apex of each of the abdominal segments.

Head densely and minutely punctate, a scarcely traceable longitudinal impression on each side in front; antennary tubercles moderately large and indistinctly tipped with red. *Prothorax* moderately transverse, subcordate, apex much wider than base, with a very feeble and indistinct median line; moderately densely and finely punctate, the interspaces densely and minutely punctate. *Elytra* flat, considerably wider than prothorax and about as long as head and prothorax combined; punctures as on prothorax, except that the larger punctures are sparser and less clearly defined. *Abdomen* feebly increasing in width from base to beyond middle, densely and very finely punctate, apex of sixth segment feebly and widely emarginate both above and below. Length 3½, to apex of elytra 2 mm.

Hab.—Tasmania: Hobart.

A comparatively large species, in appearance somewhat like *bilineatus*, but larger, less shining, the prothorax less transverse and without discal impressions, and the punctures of both prothorax and elytra smaller and different in character.

Trogophlaeus punctatus, Fvl.

I have typical specimens of this species from New South Wales and Tasmania. Some specimens from West Australia differ to a slight extent in having a more distinct median elevation on the prothorax and on each side of the elevation a distinct but slightly interrupted longitudinal impression: in typical specimens each of these impressions appears almost as two foveae.

A specimen from Windsor (N.S.W.) differs in having the elytra of a rather bright red; it is probably immature.

T. adelaidae, Blackb.

Hab.—S. Australia.

T. exiguus, Er.

Hab.—T., N.S.W.

T. bilineatus, Steph.

Hab.—W.A.: Vasse, Beverley, Swan River.

T. simplex, Motsch.

Hab.—Q., N.S.W., W.A.

Cucujidae.

Dryocora.

The Rev. T. Blackburn has called my attention to the fact that *Dryocora* and *Bessaphilus* are synonymous. *D. walkeri*, Lea, seems close to *B. cephalotes*, Waterh., but differs from the description of that species in being without the least stains of piceous (except occasionally at the apex of the prothorax); the punctures of the upper surface, though small, are certainly not

"very fine," and the space between the lateral carina and the margin is longitudinally convex.

Dryocora was proposed in 1868, *Bessaphilus* in 1877; the latter name must therefore fall. *Adelostella* has already been noted as synonymous with *Dryocora*.

Lathropus strigiceps, n. sp.

Apparently glabrous, shining. Brownish-red, head, sides (and sometimes base) of prothorax and suture more or less clouded with black.

Head longer than wide; densely punctate, the punctures (especially towards the sides) frequently confluent; a moderately feeble transverse impression behind eyes, median line absent, but punctures less crowded along middle. Antennae not extending to base of prothorax, first joint stout, almost as long as second and third combined, third to eighth subglobular, ninth and tenth wider, eleventh ovate, slightly wider than tenth. *Prothorax* longer than wide, sides very feebly rounded, apex considerably wider than base; densely and rather coarsely punctate, punctures finer along middle than at sides, sides unistriate. *Elytra* each with about six striae, of which the first, third and fifth are more distinct than the others; suture scarcely visibly punctate, elsewhere with fine and almost regular punctures. Length 2-3 mm.

Hab.—Tasmania: Huon River, Hobart, New Norfolk.

The sides of the head (especially in the male) appear to be strigose in consequence of the punctures running together. Except from certain directions the whole of the upper surface (except the apex of prothorax) appears to be glabrous; on close inspection from certain directions, however, exceedingly fine greyish pubescence becomes visible (the same is the case with the following species). In one specimen the prothorax appears to be supplied with a feeble impunctate median line. From *L. brightensis* its larger size and the entire absence of a dorsal prothoracic carina should readily distinguish it.

Lathropus piceicollis, n. sp.

Apparently glabrous, shining. Reddish, prothorax (and head to a less extent) piceous.

Head densely punctate, median line not traceable. Antennae terminated before base of prothorax, first joint stout, the length of second and third combined, third to tenth transverse, the ninth and tenth noticeably wider than the preceding ones, eleventh briefly ovate, not much longer than tenth. *Prothorax* and *elytra* as in the preceding species. Length $1\frac{1}{4}$ mm.

Hab.—N.S. Wales: Sydney.

In general appearance very close to the preceding species, but smaller, head differently coloured, eyes larger and elytra much paler. From *brightensis* its differently coloured elytra and non-carinated prothorax should readily distinguish it.

Lucanidae.

Neolamprima mandibularis, Macl.

This beautiful insect is common at Kuranda and in several other parts of North Queensland, and it varies to a remarkable extent in the mandibles of the male, and the colours of the female. Mr. Henry Hacker first informed me of the great variability of the species, and I have since heard from Messrs. Edmund Allen and J. A. Anderson to the same effect. From all three, also, I have received numerous specimens, sent as belonging to one species.

In sending a series Mr. Hacker wrote:—"With regard to *Neolamprima mandibularis*. The series sent is selected from over 80 specimens which I took near the Clohesy River, about 12 miles from Kuranda. I caught them all in two days in the same locality, *i.e.*, in a clearing in the scrub. They were all taken either flying in the hot sunshine or copulating on rotten logs. I could have taken a hundred more at the same time, had I wanted them. On examining a series of males there seem to be three well-defined forms of mandibles, long, medium and short, rather more than a gradual merging from long to short. The males do not vary much in colour, but the females vary from a deep blue, through various shades of green, to brassy red. I am perfectly convinced in my own mind that the above series represent but one species."

To judge from the examples sent by the three entomologists named, the commonest form of the male has the mandibles

fairly short (although somewhat longer than in other species of *Lamprima*), with but one tooth on the lower surface of each. In this form (which is quite a typical *Lamprima*) the mandibles are about three-fifths of the length of the prothorax.[1] The greatest length of the mandibles that I have seen is about twice the length of the prothorax.

Mr. H. H. D. Griffith has a specimen from Kuranda with the left mandible of the normal (*i.e.*, comparatively short) form, and the right noticeably longer than the prothorax. I have a similar specimen from Cairns.

Following are given (in millimetres) some lengths of the males and their mandibles, with the number of teeth on the lower surface of each mandible.

Lengths of Mandibles.[2]		Rest of Body.		Teeth on lower surface of Mandibles.
4	-	17	-	1
5	-	23	-	1
6	-	25	-	1
6	-	26	-	1
6 and 9[3]	-	23	-	1 and 6
6¼ and 8¾[3]	-	26½	-	1 and 8
6½ and 7	-	26	-	2 and 3
6 and 6¼	-	26	-	2 and 3
5½	-	22½	-	4 and 5
7	-	26½	-	3 and 4
8½	-	19½	-	8 and 11
10	-	24	-	6 and 9
10½	-	28	-	8 and 9
12½	-	28	-	8 and 11

The three terminal teeth also vary; the one at a slight distance from the apex on the upper surface is usually directed straight up, but sometimes curves slightly inwards, sometimes backwards and inwards, or backwards and outwards; in two specimens it is directed obliquely forwards. The median one of

1 A specimen of this form is standing in the Macleay Museum, under the name of *splendens*, Er.

2 Taken in a straight line and on the upper surface.

3 The specimens with uneven mandibles; if measured along their curves the differences would be still more pronounced.

the three is usually nearer the terminal one than the one near the apex, but is sometimes midway.

The females (excluding the mandibles) vary in length from 15 to 20 mm., and Mr. Hacker has well described their variation in colour, but the head is always of the same fiery red as that of the male.

A specimen with long mandibles was sent to Dr. Gestro for comparison with *N. adolphinae*, and in reply he stated:—"I have compared it with the types of *N. adolphinae*; the differences are only slight, notwithstanding they are sufficient to distinguish the two species (or the two races). The species from Mt. Arfak is less polished, the mandibles are not so robust, and the punctures of the prothorax are slightly different."

Lamprima aurata, Latr., var. *mariae*, n. var.

♂. Purple; parts of under surface metallic coppery green.

♀. Coppery-purple with violet reflections; under surface coppery red.

Hab.—Tasmania: Maria Island (W. F. McCulloch).

Mr. McCulloch has given me six specimens of each sex of this beautiful variety, all taken from old roots of "Stringy-bark" during grubbing operations.

The head is usually of the same colour as the general surface, but occasionally has a metallic green gloss. The legs of the male are mostly purple, but the tarsi are more or less metallic blue, and the femora usually have a coppery gloss. The legs of the female are beautifully variegated from a fiery red to deep purple, with brilliant greens and blues.

As I am unable to find any structural differences between the present form and *aurate*, it is simply described as a variety of that species. It is, however, quite as distinct from the typical form of that species as is *rutilans*. Some of the specimens seem to have a tendency to the deep coppery red of that variety.

CLERIDAE.

Allelidea? brevipennis, Pasc.

There are two Victorian specimens which I refer with some doubt to this species. In both the tarsi are dark (almost

black), whilst the tibiae are variable; in one one-third, in the other two-thirds at the base are dark, the rest being reddish-yellow. Pascoe describes the type as having yellow tarsi, the tibiae not being mentioned. As the legs are certainly variable in colour in two other species, it would be unsafe, therefore, to describe these specimens as new, without additional information about the type. In these specimens the dark portion of the elytra is almost in the form of a circle.

Allelidea curvifasciata, n. sp.

Black; antennae (club excepted) and parts of legs reddish; elytra with two white fasciae, one basal the other submedian. With sparse but fairly long whitish pubescence.

Head slightly wider than prothorax, with dense and fairly large punctures. Antennae short. *Prothorax* longer than wide, apex wider than base, rather suddenly inflated before the middle, punctures larger than on head. *Elytra* narrower at base than base of prothorax, and its widest portion (which is about the middle) narrower than head; sides at apical fifth finely serrated; punctures denser but scarcely larger than on prothorax, becoming somewhat smaller and sparser posteriorly. *Legs* long and thin. Length $2\frac{1}{4}$-4 mm.

Hab.—W. Australia: Swan River (A. M. Lea).

On the elytra the basal fascia appears in the form of two triangles, of which the apices meet at the base of the suture; the median fascia does not quite touch the suture, and is usually extended along the sides to about one-fourth from the apex, so as to appear in the shape of two boomerangs. On the legs the parts usually red are the trochanters and the tips of the tibiae; occasionally the red is extended to the middle of the tibiae, but the hind tibiae are sometimes entirely dark. The apex of the elytra is sometimes indistinctly diluted with red. There are seven specimens before me, all of which were taken with the sweep net.

Allelidea quadrinotata, n. sp.

Black; antennae (club excepted), parts of palpi and of tarsi and base of femora obscurely flavous; elytra with four whitish lateral spots.

Head slightly wider than prothorax, with dense and fine punctures in front, sparser and slightly larger elsewhere. Antennae scarcely longer than head is wide. *Prothorax* considerably longer than wide, apex wider than base, rather strongly inflated in middle; with moderately large, subrugose and fairly dense punctures. *Elytra* slightly narrower at base than base of prothorax, its widest portion (which is subapical) narrower than head, apices separately obtusely rounded and not serrated; with denser but not larger punctures than on prothorax. *Legs* long and thin. Length $3\frac{1}{3}$ mm.

Hab.—Tasmania: Huon River (A. M. Lea).

On each elytron one spot is beyond the middle, its widest portion on the side and its hind edge curved round so as to meet its front edge about half-way from the suture; the other spot is oblique and subapical. The four, if their inner margins were continued so as to meet, would enclose a somewhat circular space. The under surface of the front tibiae and of the tips of the four hind ones are slightly diluted with red in the unique specimen before me. It was obtained from sedges.

The species of the genus known to me may be tabulated as follows:—

Elytra dark at base - - - - - - -	*quadrinotata*, n. sp.
Elytra pale at base - - - - - - -	
Elytra not white at apex - - - -	*curvifasciata*, n. sp.
Elytra white at apex - - - - - -	
Elytra with a pale median fascia -	*ctenostomoides*, Wath.
Elytra without such a fascia - -	*brevipennis*, Pasc.

Scolytidae.

Crossotarsus mniszechi, Chp.

Mon. Platypides, p. 62, figs. 7 (♂ and ♀), 7a.

Two specimens before me, from Cairns, agree well with the description and figure of the female of this species, and Mr. Hacker had the same species (his 881) from Coen.

The species was originally described from New Guinea, Aru and Celebes. The genus[1] is now first recorded as Australian.

1 Chp., Mon. Platypides, p. 44.

Crossotarsus subpellucidus, n. sp.

♀ (?) Chestnut-brown; antennae, most of elytra of under surface and of legs paler. Head with fairly dense and moderately long golden-brown setae on vertical portion; apex of elytra and coxae with somewhat similar setae; apex and sides of prothorax and under surface with sparse and much shorter setae.

Head with a shining, dark, impunctate line on vertex, declivous portion with fairly numerous punctures of moderate size. *Prothorax* about once and one-half as long as wide; with numerous small punctures nowhere condensed into distinct spots; with a scarcely traceable, impunctate, median line. *Elytra* not much longer than head and prothorax combined; with a fairly distinct subsutural row of punctures, and traces of other rows elsewhere; near apex strongly striated, with the apex itself very finely serrated, and the sides near apex arcuated and finely serrated. Length 4 mm.

Hab.—Queensland: Cairns (E. Allen), Kuranda (H. Hacker).

The elytra, through which the wings can be easily seen, are almost flavous, but with the sides, base and suture slightly stained with brown, and the striated part at apex very dark brown. The abdomen is somewhat darker than the rest of the under surface. Of the legs the knees and tibial ridges are rather darker than the other parts. From some directions the outer angle at the apex of each elytron appears to be composed of two small spines.

There are two specimens before me of both this and the following species, and they have the apex of the elytra with the strong sculpture, that, according to Chapuis, denotes the feminine sex.

Crossotarsus armipennis, n. sp.

(♀ ?). Chestnut-brown; under surface (except abdomen) and appendages (except that the legs are in places infuscated) paler. Vertical portion of head and the coxae with moderately long and somewhat golden setae; apical fourth of elytra, and metasternum, with shorter setae; apex and sides of prothorax with sparse and still shorter setae.

Head with a feeble impunctate median line, becoming dark on vertex; declivous portion with numerous not very conspicuous punctures. *Prothorax* about as long as wide; with very indistinct punctures, nowhere condensed into distinct spots. *Elytra* about twice the length of prothorax; with regular rows of small but fairly distinct punctures: each side of apex with a strong sharp extension, projecting obliquely forwards and downwards; between this and suture a much shorter subtriangular extension. Length $4\frac{1}{3}$ mm.

Hab.—N.S. Wales (Macleay Museum).

The tip of the elytra of the female of *saundersi*, as figured by Chapuis, will give a good general idea of the tip of the elytra of this species: but the species differs from *saundersi* in being larger, with the posterior declivity different. In the present species the declivity is almost evenly rounded, opaque, and rather feebly striated.

Platypus cupulatus, Chp.

Mon. des. Platypides, 1865, p. 278, figures 167 (♂ ♀), a, b, c, d.

Mr. C. French, junr., has sent to me several specimens of this species as having been taken (alive) at Melbourne in wood from Java. It was originally described from Borneo.

Platypus solidus, Walker.

Ann. and Mag. Nat. Hist., vol. ii. (3rd ser.), p. 286; Chp. Mon., p. 267, figs. 160 and 160b, c, d.

A female from Cairns appears to belong to this species. It was originally described from Ceylon, but was recorded by Chapuis from Malacca, Celebes, Batchian and Marty. Four varieties are figured by Chapuis, and the Cairns specimen agrees closest to the typical form (figure 160).

Platypus omnivorus, Lea.

Mr. H. W. Cox has taken this species in the Illawarra district, in N.S. Wales.

Notoplatypus, n. g.

Head convex. Eyes prominent and coarsely faceted. With a short but distinct rostrum. Antennae short and rather stout;

funicle four-jointed. *Prothorax* subcylindrical, each side with an impression for the reception of front femur. *Scutellum* absent. *Elytra* elongate, cylindrical, apex roughly sculptured. *Prosternum* elongate in front of tibiae, with a flange-like extension behind. *Mesosternum* with a short extension concealed under flange of prosternum. *Metasternum* very elongate. *Abdomen* with first segment (along middle) shorter than second and third combined, third and fourth with deep sutures, each about as long as second and shorter than fifth. Front *coxae* touching, the others moderately separated; femora short, stout, compressed and edentate; tibiae short, serrate; tarsi long, thin and five-jointed, first and fifth elongate, first distinctly shorter than the rest combined.

The species described below in appearance is something like a long, thin *Platypus*, but is readily distinguished from that genus by the distinct rostrum; with larger, coarsely faceted and more convex eyes. The front coxae, although large, are much smaller than in *Platypus*. The rostrum, including the mandibles, is twice as wide as long; in the other genera of the *Platypides* it is much shorter.

The scape is stout; first joint of funicle concealed within apex of scape, second stout and rather long, third and fourth conjointly strongly transverse and indistinctly separated; club solid, apparently one-jointed. The scape when removed from the head is about the length of the club and slightly longer than the funicle. The latter, from above, appears to be two-jointed only, and from below three-jointed; the separation of the third and fourth joints is quite invisible under a Coddington lens.

Notoplatypus elongatus, n. sp.

Reddish castaneous, head somewhat darker. Apex of elytra with fine golden setae or pubescence, elsewhere glabrous or very sparsely pubescent.

Head with distinct but not large or dense punctures. Rostrum convex and with finer punctures than on head in one sex, gently concave and with coarser punctures than head in the other; in both with a short median line. *Prothorax* not quite twice as long as wide, sides gently incurved to middle; with

clearly defined but rather small, irregularly distributed punctures, denser on basal half than apical, and clustered together in a small spot on each side of the middle, slightly closer to base than apex. *Elytra* a little more than twice the length of prothorax; striate-punctate, punctures rather large but shallow; interstices wider than striae, with numerous small punctures, third increasing in width near base, the widened portion granulate-punctate in one sex, with simple punctures in the other; posterior declivity with almost regular rows of small granules in one sex, in the other with several much more conspicuous granules or small tubercles on the third and fifth interstices. Front *tibiae* rather thin and finely serrated, the others stouter, of different shape, and rather coarsely serrated. Length 6¼-6½ mm.

Hab.—N.S. Wales: Ropes Creek (Macleay Museum), Galston (A. M. Lea).

In addition to the ordinary punctures the whole of the upper surface, in suitable lights, appears to be very finely shagreened. The sexes are readily distinguished by the base and apex of elytra, but I am unable to state which is the male.

Tomicus acanthurus, n. sp.

Pale reddish castaneous, parts of under surface almost flavous; mandibles, elytral tubercles and margins, knees, and sutures of metasternum more or less blackish; prothoracic granules and middle of disc more or less infuscate. Clothed with rather long, and not very sparse, pale hair or thin setae.

Head with punctures of irregular size and distribution; with a very feeble median carina. Scape about twice the length of funicle, and distinctly longer than club. *Prothorax* moderately transverse, apical half semicircular; with irregularly distributed punctures, denser on middle of disc than elsewhere; apical half with transverse series of narrow granules. *Elytra* with small but distinct punctures, irregularly distributed; posterior declivity commencing before the middle, each side of it with three rows of large shallow punctures; its outer boundaries marked by an irregular double row of large conical granules, or small tubercles, each of which is marked with a puncture containing

a hair or seta at its tip. Front *coxae* almost touching; front tibiae scarcely, the hind pair distinctly, but irregularly, serrated. Length 7½ mm.

Hab.—Queensland: Cairns.

The only specimen now before me was obtained from Mr. E. Allen or Mr. H. Elgner, and its middle tibiae are missing. There is, however, a specimen from Cape York in Mr. J. A. Anderson's collection. The elevations of the prothorax are, perhaps, not properly called granules, each appears as a small acute ridge, distinctly separated from its fellows, but so placed as to appear a remnant of a transverse blade-like ridge; in the middle of the extreme apex they are more distinct and closer together, giving it a serrated appearance.

Among the Australian Scolytidae readily distinguished by its large size, robust form, and conical tubercles margining the posterior declivity. The only species previously referred to *Tomicus* from Australia is *truncatus* (*Amasa thoracica*), which is a much smaller species, with the posterior declivity abrupt and not margined with tubercles.

Xyleborus compressus, Lea.

The elytra of this species are usually very little darker than the prothorax. On their posterior declivity there are two small subconical tubercles on the third interstice on each side. The species occurs in Queensland, Victoria and Tasmania, as well as in New South Wales.

Xyleborus parvus, Lea.

There are a few small granules on each side near the apex of the elytra of this species.

Xyleborus hirsutus, Lea.

There are numerous small acute granules on the posterior declivity of this species; and the elytra, instead of being once and one-fourth the length of the prothorax, as in the original description, are fully once and one-half its length.

The species occurs in Queensland, as well as in N.S. Wales; and Mr. C. French, junr., has obtained numerous living specimens at Melbourne, in logs from the Malay Peninsula.

Xyleborus funereus, n. sp.

Deep black and shining, under-surface somewhat diluted with red; antennae and tibiae somewhat flavous, rest of legs darker. With rather long and more or less erect yellowish setae or hairs, somewhat irregularly distributed.

Head with numerous punctures of moderate size, but not sharply defined. *Prothorax* about as long as wide, apical two-fifths strongly granulate-punctate, middle of disc with small dense punctures, elsewhere almost impunctate. *Elytra* not twice the length of prothorax; with regular rows of distinct, but not large punctures; posterior declivity with small scattered granules, becoming small conical tubercles on the third interstice. *Tibiae* strongly curved and serrated outwardly. Length 3½ mm.

Hab.—Queensland: Cairns (E. Allen).

The deep black colour of the entire upper surface will readily distinguish from all previously described Australian species; in build it is much like *compressus*, but there are three conical granules on the third interstice, instead of only two. A second but much smaller black species occurs in Queensland, but, as it is represented before me by a single broken specimen, it is not now described.

Cryphalus compactus, n. sp.

Of a rather dingy flavous, granules somewhat darker. Clothed with very fine pale pubescence, and with fine suberect setae.

Prothorax not much wider than the length down middle; with dense minute punctures; with numerous rather rough granules, more or less transversely arranged. *Elytra* about once and one-half as long as wide; with dense minute punctures, and feeble remnants of striation. Length 2 mm.

Hab.—Queensland: Port Denison (Australian Museum).

A pale robust species. The granules occupy almost the entire width of the prothorax at apex, but then they disappear hindwards from the sides, and terminate in the middle before the base is reached, so that in front the space occupied by them is rounded, and behind triangular.

A specimen from the Upper Ord River may represent a variety of this species; it differs from the types in being slightly narrower, with the elytral setae more pronounced.

Cryphalus subcompactus, n. sp.

Piceous-black; appendages reddish-flavous, tarsi still paler. Clothing of the same nature as in the preceding species, but darker.

Prothorax almost as long as wide; with dense minute punctures; and dense angular granules, more or less transversely arranged. *Elytra* almost twice as long as wide, with dense minute punctures, and very fine but fairly distinct striae. Length $1\frac{1}{2}$-$1\frac{2}{3}$ mm.

Hab.—N.S. Wales: Galston (D. Dumbrell), Sydney (A. M. Lea).

The length is about that given for *wapleri*, but the elytral clothing and sutural stria are not as described in that species. The prothoracic granules are rather more closely placed than in the preceding species, and terminate hindwards rather more abruptly; the elytral striae are also rather more noticeable, although very finely impressed.

An immature specimen which belongs to this species is in general appearance very close to two European species which I have under the names of *piceae* (Ratz) and *asperatus* (Gyll), but is slightly more compact, with the clothing slightly different.

Cryphalus melasomus, n. sp.

Black; tibiae more or less diluted with red, tarsi and antennae flavous. Clothed with fine dark pubescence and fine suberect setae.

Prothorax moderately transverse; with dense and fairly distinct punctures; apical half, except at sides, with coarse angular granules, more or less transversely arranged. *Elytra* rather more than twice as long as wide, with rows of small but distinct punctures in fine striae, the striae rather stronger towards sides than suture. Length 2 mm.

Hab.—N.S. Wales: Clarence River (G. Compere), Wollongong (A. M. Lea).

Much smaller and darker than *pilosellus*, with the legs not entirely pale, prothorax with coarser punctures and sparser granules, etc. The uniformly black prothorax distinguishes from the description of *sidneyanus*, and the larger size and sutural stria not profoundly impressed at base from the description of *wapleri* (the colour of which is not mentioned). The clothing is much as in the preceding species, except that the fine pubescence is slightly longer and more noticeable. In general appearance it is much like the European *binodulus*, but is more compact, punctures coarser, with the striation more pronounced and regular.

The granules are almost entirely confined to the sloping apical portion of the prothorax, and, from above, the space they occupy appears to be almost circular. On one specimen the club is concolorous with the rest of the antennae, on the other it is somewhat darker.

Cryphalus setistriatus, n. sp.

Black; appendages flavous, knees and club darker. Clothed with fine greyish pubescence, the elytra with short, stout, suberect setae, in regular series.

Prothorax about as long as wide; with small dense punctures, and with numerous somewhat angular granules, more or less transversely arranged. *Elytra* more than twice as long as wide; with regular rows of distinct punctures in fine striae. Length $1\frac{1}{2}$ mm.

Hab.—W. Australia: Rottnest Island (A. M. Lea).

The granules are smaller, more numerous and less angular than in any of the preceding species, and their transverse arrangement is less conspicuous; the punctures are also more noticeable. The elytral setae in this and the three following species are very different to those of the three preceding species.

Cryphalus tricolor, n. sp.

Blackish-brown, prothorax reddish, appendages flavous. Clothed with very fine whitish pubescence, the elytra in addition with very short, stout, suberect setae, in regular series.

Prothorax almost as long as wide, with small dense punctures;

apical half with numerous small angular granules, of which those in front form three almost perfectly regular rows. *Elytra* about twice as long as wide; with dense minute punctures, and with larger (but still small) punctures in regular series. Length $1\frac{1}{2}$ mm.

Hab.—Queensland: Cairns (E. Allen).

The reddish prothorax readily distinguishes from all other species known to me.

The elytral setae are very short, and from above appear almost as if scales. The granules on the middle of the prothorax have a somewhat regular arrangement, but not so complete as the three apical rows. There are faint traces of striae at the base and sides of elytra, but true striae are quite absent from the disc, although the rows of punctures are quite regular.

Cryphalus striatopunctatus, n. sp.

Piceous-black; appendages flavous, club darker. Indistinctly clothed with greyish pubescence; the elytra in addition with regular series of rather short and fairly stout setae.

Prothorax about as long as wide; with rather small dense punctures; apical half, except at sides, with numerous small angular granules, scarcely transversely arranged. *Elytra* rather more than twice as long as wide; with regular rows of (for the genus) comparatively large punctures, becoming smaller posteriorly, and in rather lightly impressed but quite distinct striae. Length $1\frac{1}{4}$ mm.

Hab.—N.S. Wales: National Park, Sydney (A. M. Lea).

Distinguished from *setistriatus* by the more convex elytral interstices, with larger punctures in the striae; in shape also it is slightly less elongate.

One specimen is entirely flavous (except that the granules are somewhat darker), but this is probably due to immaturity.

Cryphalus tantillus, n. sp.

Brownish-flavous, appendages flavous. Clothed with fine greyish pubescence; elytra in addition with short, stout, erect setae, in regular series.

Prothorax feebly transverse; with dense minute punctures; apical half (except at sides) with small, dense, angular granules, feebly transversely arranged. *Elytra* more than twice as long as wide; with regular rows of distinct punctures, in feeble striae; the interstices with minute punctures. Length 1 mm.

Hab.—N.S. Wales: Richmond River (A. J. Coates).

The smallest of the family recorded or known to me from Australia, and with the elytral setae beautifully regular. In general sculpture it is much like the preceding species, except that the punctures and striae are rather less strongly impressed.

Cryphalus pilosellus, Er.

A fairly common Tasmanian species, varying in length from 2 to 2⅔ mm. Numerous specimens (apparently immature, as they are much paler than specimens taken at large) were taken from beneath bark of the prickly box (*Bursaria spinosa*).

Hylesinosoma, n. g.

Head wide, not entirely concealed from above. Eyes narrow and finely faceted. Scape more than thrice the length of funicle, and slightly shorter than club; funicle seven-jointed; club with three very conspicuous joints, of which the first two are strongly produced on one side. Rostrum (including mandibles) almost thrice as wide as long. *Prothorax* moderately transverse, base bisinuate. *Scutellum* small. *Elytra* cylindrical, subcordate. *Prosternum* short. *Metasternum* slightly longer than the following segment; episterna wide at apex. *Abdomen* with first segment rather more than twice as long as second or fifth, each of these slightly longer than third or fourth. Front *coxae* separated about half the length of front femora, middle coxae a little more widely separated, hind pair almost touching; femora rather stout and edentate; tibiae coarsely serrated; tarsi shorter than tibiae.

This genus is proposed to receive *Hylesinus fici*, wrongly referred to *Hylesinus* on account of its very deceptive resemblance to several exotic species of that genus. In the figure accompanying the original description of the species the funicle is

figured as two-jointed, and that is certainly its appearance under a Coddington lens, but under a quarter-inch power seven joints may be seen, the first small and almost (from above, quite) concealed by the scape, the second fairly distinct, and then five very closely connected and strongly transverse joints, regularly and conjointly increasing in width to apex. The claw joint has a minute basal piece, so that the tarsi are really five-jointed. It certainly does not belong to *Hylesinus*, which has a subsolid club, and it certainly belongs to the *Phlaeotribi*, as defined by Leconte, who does not mention the number of joints of the funicle. Chapuis gives as a sub-family character of the *Phloeotribidae* the funicle as five-jointed. On the whole it seems best to refer the genus to the vicinity of *Phloeotribus*.

Hylesinus cordipennis, n. sp.

Black or almost black, antennae and tarsi reddish, knees and tips of tibiae more or less diluted with red. Clothed with very fine pubescence, longer and more noticeable about mouth and on coxae than elsewhere.

Head with very dense and rather small punctures, face gently concave. *Prothorax* about as wide as the length down middle, but much shorter at sides, sides strongly rounded, base with a strong scutellar lobe, a very shallow curved impression on each side of base; with very dense and rather small punctures; towards sides granulate-punctate. *Elytra* cordate; striate-punctate, punctures deep and suboblong; interstices flattened, very densely punctate, towards base granulate, and everywhere wider than striae. *Under surface* with dense, clearly-defined punctures. Front *coxae* separated about half as much as the middle pair; tibiae dilated to apex and rather strongly serrated. Length 3-3¼ mm.

Hab.—Queensland: Cairns (J. A. Anderson).

Under a quarter-inch lens the funicle is quite distinctly seven-jointed, the first being fairly long, the others strongly transverse and close together, but the second longer than the others. The joints of the club have oblique and fairly distinct sutures, and the club itself is somewhat darker than the rest of the antennae.

This and the following species are both larger than *porcatus* (described as $2\frac{1}{3}$ mm. in length), and both have the elytral interstices considerably wider than the striae, and with very different clothing; *fici* (erroneously referred to *Hylesinus*) has a very different club.

Hylesinus interstitialis, n. sp.

Colour much as in preceding species, except that the reddish parts are rather less conspicuous. Upper surface glabrous, except for some short, pale, stiff setae on apical half and sides of elytra; face with fine pubescence; under surface and legs with moderately dense and not very short pale pubescence.

Head with very dense and rather small, but round and clearly-defined punctures. *Prothorax* about once and one-third as wide as long, sides strongly rounded in front, but almost parallel on basal half, base feebly bisinuate; basal half with a very feeble median line; sides, except at apex, very narrowly margined; with dense, round and clearly-defined, but not very large punctures. *Elytra* oblong-cordate, apex conjointly mucronate; striate-punctate, punctures more or less round and confluent, causing the interstices to appear finely crenulated; these flattened, much wider than striae, and with numerous clearly defined punctures. *Under surface* with dense but partially concealed punctures. Front *coxae* separated almost as widely as the middle pair; four hind tibiae coarsely serrated. Length $3\frac{1}{2}$-5 mm.

Hab.—Queensland: Cairns (Macleay Museum, H. Hacker, E. Allen).

Although, at a glance, close to the preceding species, differs from it in the shape, clothing, punctures, antennae, separation of front coxae, etc.

The funicle has the first joint stout and about half the length of the rest combined, the second is fairly distinct, but the others are so strongly transverse and close together that it is difficult to decide as to their number, more especially as the apical one is closely joined to the club. Under a quarter-inch lens, however, and in certain lights, the funicle can certainly be seen to be seven-jointed. The scape is the length of the

funicle. The club is finely pubescent; distinctly longer than the funicle and oblong-elliptic; it is composed of three joints, with strongly oblique sutures; but these are so very indistinct that at first the club appears to be solid, and it is only in certain lights and from certain directions that the sutures can be seen at all.

Phloeopthorus acaciæ, n. sp.

Dark brown, sometimes almost black; antennae (club darker), tibiae and tarsi reddish. Clothed with short, stout, pale setae, more or less closely applied to the derm; the elytra in addition with regular rows of short, stiff, semi-upright setae.

Head with moderately dense but partially concealed punctures. Scape stout, somewhat shorter than funicle; funicle with first joint stout, curved at base and longer than any of the others; second slightly longer than third; club distinctly longer than funicle, about twice as long as wide, rather pointed, sutures distinct and not oblique. *Prothorax* about once and one-half as wide as long; with dense but more or less concealed punctures; sides rather strongly rounded; base strongly bisinuate. *Elytra* elongate-cordate, no wider than prothorax and about twice as long; striate-punctate, striae and punctures in same partially concealed; interstices wider than striae, and with numerous punctures, at base each separately raised, except the sutural one on each side. Second segment of *abdomen* about half the length of first, and not much longer than third. *Tibiae* dilated to apex. Length 2-2¼ mm.

Hab.—Tasmania.

Abundant in dead and dying wattle trees, just beneath and in the bark. The elytra are usually as dark as the rest of the upper surface, but are often more or less reddish; the femora and coxae are also sometimes reddish. Seen from in front the raised interstices at the base of the elytra appear like a fine curved saw, with a gap at the suture. The funicle under a quarter-inch power is quite distinctly five-jointed, the second to the fifth joints being each dilated to apex, so that each is quite distinctly visible.

Ficicis, n. g.

Head wide, not concealed. Eyes thin, feebly curved, about as long as front tibiae, facets not very small. Rostrum short and stout. Scape stout, distinctly longer than funicle; funicle seven-jointed, first joint stout, about as long as three following combined, and feebly or not at all dilated to apex; club longer than funicle, but not twice as long as wide, with distinct straight sutures, apical joint small. *Prothorax* transverse, base bisinuate. *Scutellum* small. *Elytra* cylindrical, apex rounded. *Prosternum* extremely short in front of front coxae. *Metasternum* about as long as the following segment; episterna greatly narrowed in front. *Abdomen* with first segment almost as long as three following combined, second as long as fifth, and distinctly longer than third or fourth. Front *coxae* distinctly separated, the space between them about equal to the width of club, middle pair more widely, hind pair rather less widely separated; femora rather short, edentate; tibiae increasing in width to apex serrate at and near apex; tarsi rather thin.

In the Australian fauna this genus may be placed next to *Hylesinus*. In general appearance the two species described below are remarkably close to *Phlaeopthorus acaciae.*

Ficicis varians, n. sp.

Colour variable. Clothed with short stout pale setae, denser and finer on the abdomen than elsewhere; on the elytra stouter than elsewhere, suberect and in regular series.

Head regularly convex, with very indistinct punctures. *Prothorax* about once and one-third as wide as long, apex about two-thirds the width of base; with dense and fairly large, but not deep, punctures. *Elytra* about twice the length of prothorax, and no wider; striate-punctate, punctures large, deep, and close together; interstices narrower than striae, and finely serrated; base, except at suture, narrowly raised. Length 2-2 1-6th mm.

Hab.—N.S. Wales: Gosford (from dying trunks of cultivated fig, W. B. Gurney), Sydney (A. M. Lea).

One specimen has the head, prothorax, scutellum and femora black, with the elytra and under surface dark reddish-brown,

and the tibiae, tarsi and antennae (excepting club, which is dark) more or less reddish. Others are almost entirely flavous-red, or entirely dark-red. Others are more or less reddish, with the prothorax (except at its apex) and head darker, and femora darker or not. Seen from the sides, each elytral interstice appears to be finely serrated, the serrations being caused by granules, some of which become more conspicuous towards the apex; the punctures, though of large size, are somewhat obscured by the clothing.

Ficicis koebelei, n. sp.

Reddish-brown or black, scape funicle, and tarsi paler. Clothed with short, stout, pale setae; depressed, except on elytra, where it forms regular series; on abdomen denser and finer than elsewhere; prothorax and elytra, in addition, with very fine indistinct pubescence.

Head regularly convex, with very minute and indistinct punctures. Rostrum concave in middle. *Prothorax* about once and one-half as wide as long, apex slightly more than two-thirds the width of base; with very dense punctures, rather small on disc, but becoming larger and subgranulate towards sides and apex. *Elytra* about twice as long as prothorax, and just a trifle wider; striate-punctate, punctures large, but partially concealed; interstices narrower than striae, granulate-serrate suture depressed at base, but rest of base not finely raised. Length 2 1-3rd mm.

Hab.—Queensland (Henry Hacker), Barron Falls (A. Koebele).

Two specimens are almost or quite black, another is blackish with the elytra somewhat paler, and three others are nowhere (except the eyes) black. Seen from the sides, the granules of the elytral interstices cause these to appear very finely serrated, as in the preceding species. But it differs from that species in being slightly larger and wider, with the elytral clothing of two kinds, with the base not raised, and the prothoracic punctures different.

Two specimens from Cairns may represent the other sex of this species, or possibly a distinct one. They differ in having no elytral granules, and consequently the serrated appearance

of the interstices wanting; the finer pubescence of the prothorax and elytra is also more conspicuous. The club is also pale, but this may be a variable character.

Acacicis, n.g.

Head rather small, visible from above. Eyes narrow, with rather fine facets. Rostrum extremely short. Scape rather stout, shorter than funicle; funicle seven-jointed; club stout, slightly longer than funicle, sutures rather indistinct. *Prothorax* transverse. *Scutellum* absent. *Elytra* not much longer than wide. *Prosternum* very short, and not continued in front of coxae. *Metasternum* very short. *Abdomen* slightly wider than long; first segment (excluding its triangular intercoxal process) the length of fifth, and but little longer than second, second not much longer than third or fourth. Front and middle *coxae* very widely separated, hind pair almost touching; femora rather short, edentate, tibiae dilated and finely serrated towards apex; tarsi rather thin, claw joint about equal to the combined length of the others, and with rather strong claws.

In the Australian fauna this genus may be placed next to the preceding, from which, and from all others, it may be distinguished by the following combination of characters:—Very widely separated front coxae, with hind pair practically touching[1]; seven-jointed funicle. and club with indistinct sutures.

Acacicis abundans, n. sp.

♂ (?) Black or blackish-brown; scape, funicle and tarsi reddish; rest of legs and part of elytra sometimes reddish. Clothed with rather dense, greyish (or brownish) setae or pubescence, suberect on elytra.

Head without distinct punctures. *Prothorax* about once and one-third as wide as the length down middle, but about twice as wide as the length of sides, base with a wide scutellar lobe; extreme apex with a few small granules in middle; with dense and small, partially concealed punctures, becoming larger and more distinct towards apex and sides. *Elytra* briefly cordate,

1 The three coxae on each side, however, are practically touching, owing to the extreme brevity of the sterna.

very little wider than prothorax; striate-punctate, punctures fairly large, but partially concealed; interstices with numerous granules, of which the most conspicuous is on the fifth interstice, forming a preapical callus; interstices separately raised at base. Length $1\frac{1}{2}$–$1\frac{3}{4}$ mm.

♀ (?) Differs in having the elytra more convex and cylindrical, without granules, except the preapical callus, and a few at base caused by the elevation of the interstices there; the striation rather feeble, with small punctures, and the interstices with numerous small punctures.

Hab.—Tasmania (Aug. Simson, No. 2074), Hobart, Mount Wellington, Bruni Island, etc.; Victoria: Emerald (A. M. Lea).

A small subglobular species, that may be taken in abundance on dead and dying wattle trees, especially when newly barked. The elytra, especially in the male, are frequently diluted with red, except at the base and sides. The funicle has the first joint stout, briefly elliptic, and longer than any other, second about half the length of first, and about the length of third, third to seventh gradually increasing in width, very close together and closely joined to club. The six apical joints are so close together that it is impossible to distinguish them under a hand lens, and even under a compound paper a suitable light is very necessary. On the male there are eight rows of conspicuous granules on each elytron, of which the first four rows are short and subbasal, the fifth is slightly longer, and the sixth and seventh are longest of all, and curve round so as to join in with the preapical callus of the fifth: the seventh and eighth are also rather short, but are not subbasal.

A second and smaller species from New South Wales is known to me, but only from the female, so is not now described.

Brenthidæ.

Ectocemus 10 maculatus, Montr.[1]

ruficauda, Bates.

var. *pterygorrhinus*, Gestro.

In many Australian collections I have seen specimens of a remarkable Brenthid standing under the name of *E. ptery-*

1 Ann. Soc. Agr. Lyon, vii., i., p. 37.

gorrhinus; but these specimens do not agree with Gestro's description. I wrote about the species (my 10804) to Dr. Gestro as follows:—"This species is in several collections as *pterygorrhinus*, but it does not agree with your description, as the prothorax is red, and the maculae are never ten in number, but eight or nine, of which three or four are together beyond the middle and never more than two at the apex (in your description you say three)." In reply he stated: "Nearly all our Brenthids are with Prof. Senna, to whom I sent your specimens. Senna says your 10804 is *Ectocemus 10 maculatus*, Montr." In a later letter he confirmed this identification, and stated: "I think that *pterygorrhinus* is simply a colour var., and in consequence the two cannot be separated, *pterygorrhinus* is darker."

In recently examining twenty-four specimens of the species I found that one of them has three apical spots on each elytron, but the one usually missing (at the junction of the fourth, fifth and sixth interstices) is very small. Several specimens sent to me recently by Mr. Elgner from Cape York have the prothorax quite black, but in all the others it is of a more or less dark red. Queensland specimens vary in length from 16 to 28 mm. (including the rostrum).

In Masters' Catalogue of the New Guinea beetles, *ruficauda* Bates (1394) is given as a synonym.

Orychodes digramma, Boi.[2]

This species (originally described from Dorey) occurs abundantly in the vicinity of Cairns. In appearance it resembles an *Ectocemus*, but has a stout spine directed at right angles to its length, immediately behind each eye; the spine, however, is usually very indistinct in the female. The length (including the rostrum) varies from 9 to 20 mm. I have to thank Dr. Gestro for the identification of the species.

CHRYSOMELIDÆ.

Sub-family, *Chrysomelides*.

The late Mr. Jacoby's paper in Ann. Soc. Ent. Belge, 1898, was unknown to me at the time I drew up the descriptions of

2 Voy. Ast., II., p. 310, t. vii., f. 23.

some species of this sub-family, which appeared in the Proceedings of the Aust. Assn. for the Advancement of Science. Although my paper was "read" in 1902 it was prepared some time before then, and before starting on it I had seen no references to his paper in the Zoological Record.

For several of the species[1] the locality "Richmond" given by Jacoby is certainly wrong. Richmond is a town on the Hawkesbury River, near Sydney, and I have seen no species of most of the genera referred to so far south. The locality should almost certainly have been Richmond River, where numerous species of the genera referred to are to be obtained.

Phyllocharis gracilis, Jac.

Redescribed by me as *P. fici*.

Stethomela foveipennis, Jac.

This is a synonym of *poroptera*, Baly.

Stethomela fulvitarsis, Jac.

My *cupripes* appears to be close to this species, and is perhaps only a variety of it; it differs from Jacoby's description in having the antennae without the basal joint piceous above; the tarsi, except the claws, entirely dark, the under surface not piceous, and the upper surface wihout a trace of green.

Richmondia camelus, Jac.

This species was previously described by Blackburn with doubt as a *Spilopyra* (*olliffi*, Blackb.). The species must therefore now be known as *Richmondia olliffi*, Blackb.

Augomela ignita, Jac.

This is the same species that I subsequently described under the same name (as supposed by Blackburn), although Jacoby's types were larger than mine. There is therefore no need to change my name as being already in use.

1 *Phyllocharis gracilis, Chalcomela variegata, Augomela ignita, Platymela blackburni* and *Richmondia camelus*.

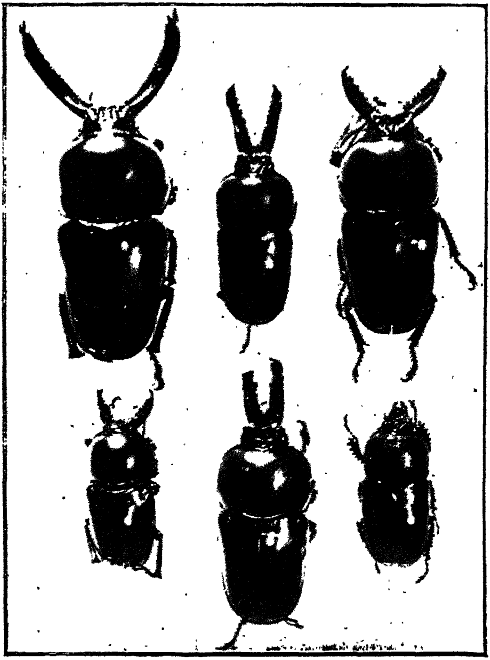

Photo by A. Conlon

Neolamprima mandibularis, Macl.

The two figures on the left show the range of variation in size and mandibles. The lower middle figure has the left mandible as in normal species of *Lamprima,* whilst the right is typical of *N. mandibularis.*

[Proc. Roy. Soc Victoria, 22 (N.S), Pt. II, 1909.]

Art. XII.—*A Contribution to the Physical History of the Plenty River; and of Anderson's Creek, Warrandyte, Victoria.*

By J. T JUTSON.

(Victorian Government Research Scholar).

(Plates XXXI–XXXII., and two Text Figures).

[Read 11th November, 1909]

THE PLENTY RIVER.

Description of the Valley.

This river rises in Mount Disappointment, and runs practically due south until it meets the Yarra to the west of Templestowe. Its basin was geologically surveyed by the old Geological Survey of Victoria, and the geology is accurately delineated on Quarter Sheets 3 N.E., 3 S.E., 2 N.E., 2 S.E., and 1 N.E. In its course from source to mouth, the river passes through granitic, basaltic and sedimentary silurian and tertiary rocks. In the granitic area of Mount Disappointment, the eastern and western branches are each split up into a number of small streams, which, upon reaching the silurian country, soon unite to form the two branches mentioned. Bruce's Creek, which joins the Plenty at Whittlesea from the north-west, is its largest tributary, and is, in fact, the main stream.

The character of the valley of the Plenty immediately invites investigation. In the neighbourhood of Whittlesea, the stream is sluggish, shallow and meandering. It runs through its own alluvial flood-plain (which in places is a mile wide), bounded by subdued hills; and, with its tributaries, presents all the features of a matured river system. Below the Yan Yean Reservoir the Plenty meets the newer basalt, through

which it has cut its way. After traversing this formation for about two miles, it finds its way to the junction of the basalt and the silurian, but breaks away into the latter in two places, and also cuts through the basalt a similar number of times. Apart from these deviations, however, it keeps to the junction mentioned to Morang; then is bounded in different parts by older and newer basalt, and tertiary and silurian sediments (the silurian predominating), until it reaches the Yarra. From the time the river enters the newer basalt until it finds the junction with the silurian, its valley in the basalt does not become more than about 30 feet deep; but when it reaches the sedimentary rocks, it soon becomes a winding gorge, whose deepest part is near Morang, where it obtains a depth of close upon 250 feet from the surface of the newer basalt plain. The latter is lower than the opposite or eastern ridge of older rocks; so that from this side the depth would be greater. Here the valley is markedly V-shaped in cross section and is of rugged beauty. Its sides are steep and densely clothed with timber, and the newer basalt outcrops in large boulders, mainly on the right bank, at the top of the valley; while some splendid silurian sections are displayed on each side. In cross profile, the spurs show the steep short cliff of the basalt, and the longer, more gentle slope of the silurian beneath. After the newer basalt is left behind, the outlines of the valley become softened, as at Greensborough, but the youthful character of the stream is most obvious. A noticeable feature is the absence, south of Morang, of all but the most insignificant tributaries. At South Yan Yean and Morang, the newer basalt partly fills a large old valley, which is comparatively contracted at Morang, with high bounding ridges, but is wide and open at South Yan Yean, with lower ridges forming its sides.

Previous Literature and Remarks Thereon.

The only previous references to the physical history of the Plenty valley appear to be by Mr. T. S. Hart, M.A., and Prof. Gregory. Mr. Hart, in his interesting and suggestive paper, "The Volcanic Rocks of the Melbourne District,"[1] referring to

1 Victorian Naturalist (1894), vol. xi., pp. 74-78.

the flow of the newer basalt, states that "the lava streams extend to the east into the Plenty valley; thence southward down a narrow valley in the silurian rocks west of the present Plenty River, joining the man basaltic area south of Morang. . . . The width of the old valleys here seems quite out of proportion to the streams which flow down them; the Plenty River old valley is represented by a strip of basalt scarcely a mile wide, while on the other side of the Morang Hills the Darebin and Merri occupy a basaltic plain seven miles wide. The Plenty and all its tributaries that meet the basalt show extensive alluvial deposits above it, as if their flow had been checked; and it seems probable that all these tributaries formerly passed to the west of the Morang Hills, and perhaps the Plenty itself turned in the same direction."[1]

The hills referred to by Mr. Hart as the Morang Hills form the elevated silurian inlier with granite intrusions, shown on Quarter Sheet 2 N.E. Mr. Hart recognises the effect of the basaltic flow in largely blotting out the old valley, and in the formation of extensive alluvial deposits farther up stream, but his opinion as to the old course of the Plenty is not clear. His reference to the old Plenty valley, represented by a strip of basalt scarcely a mile wide, would fix the valley between the Morang Hills on the west, and the silurian rocks to the east of the present stream on the east; but he also thought it probable that all the tributaries of the Plenty formerly passed to the west of the Morang Hills, and that perhaps the Plenty itself turned in the same direction. In dealing with such a wide area as is covered in his paper, Mr. Hart's remarks as to the Plenty were necessarily condensed. From a recent correspondence with him I gather that he inclined to the opinion that the Plenty at the time of the newer basalt flow ran north-west of the Morang Hills, a course which he considers would be explicable as a result of capture of an old south-flowing stream by a tributary of the Merri, though at the time he did not deal with this earlier history of the Plenty.

Prof. Gregory in his Geography of Victoria (1903) states[2] that the Plenty flows south through a broad mature valley,

1 Ib., p. 77.
2 p. 112.

changing near Melbourne (? Morang) to a deep gorge, which has all the characters of a young valley. The change, he remarks, is due to the fact that the old valley has been filled up by a flood of lava (i.e., the newer basalt), that the river has had to cut its channel anew, and that, owing to the hardness of the basalt, the river has corroded its bed along the junction between the basalt and the softer silurian sandstones and shales. Prof. Gregory also maintains[1] that the King Parrot Creek and the Plenty River were probably originally one consequent river. This question is outside the scope of the present paper, and is not therefore discussed.

The remarks of both Prof. Gregory and Mr. Hart throw light on the history of the Plenty. They do not furnish a complete explanation of how the present conditions arose; but it must be remembered that they were only dealing in a general way with the subject. Mr. Hart recognises possible changes in the course of the upper Plenty; while Prof. Gregory notes that the old valley (along the present course) has had a stream of lava poured into it, and that the river has had to re-excavate between the basalt and the silurian. He also remarks on the broad mature valley up stream, and the youthful valley lower down; but he does not suggest any change in the actual course of the river.

The Later History of the Plenty.

An examination of the nature and relative position of the various geological formations along the course of the Plenty is necessary, in order to appreciate its later history. As already mentioned, at Whittlesea and Yan Yean the river meanders through an alluvial flood-plain of about a mile in width, until it meets the newer basalt. This broad alluvial plain (together with the widening of the upper tributaries) has no doubt been caused in part by the hard basalt damming the stream; or at least so retarding vertical erosion that lateral erosion took place, and built up the flood-plain. That the upper part of the valley, however, was, prior to the flow of the basalt, considerably developed, is indicated by the width of the old valley

1 Ib., p. 113.

near South Yan Yean. Looking from the elevated ridge which forms the eastern side of this valley, at a point about a mile south of Doreen, and just to the east of the road running from Doreen to the main Diamond Creek Road, a great low-lying valley, whose western side is over three miles away, is seen. Newer basalt (through which the present Plenty is cutting) occupies the floor of this valley, and has passed up some of the eastern tributaries.

It is evident, therefore, that the valley existing when the newer basalt was erupted was a wide, well-matured one. Lower down, near Morang, this old valley narrows, but still is moderately developed, as the distance from crest to crest of the bounding ridges (probably just under 2 miles) shows. These ridges are higher than their continuation northward, and this is perhaps due to the rocks to the north being softer and having suffered more denudation. The western ridge at Morang consists of granite[1] intrusive into the silurian, which has been hardened and indurated. The hardness of the rocks forming the eastern ridge is not so obvious; but many sections in the Plenty show thick beds of sandstone, which evidently has considerable resisting power here. The height of the western ridge at Morang is also explained—as noticed below—by the probability that its top formed a monadnock on the peneplain, out of which the old valley was carved. South of Morang, the old valley apparently ran to the south-west. This old valley appears to have been that of the original Plenty (i.e., the stream formed on the uplift of the peneplain); but whether, in view of Mr. Hart's suggestion, it remained so until the eruption of the newer basalt, is not certain.

The determination of this point is not, however, material, for the main purpose of this paper; but it might be observed in passing that the gap in the western ridge near Yan Yean, where Barber's Creek now enters (which is the point where the old Plenty would turn to the west if captured by a tributary of the old Merri Creek) could be made by a tributary of the old Plenty, just as well as by the backward (eastward) erosion of this old tributary of the Merri Creek. This gap has a parallel on the eastern side of the Plenty, where the tributary streams,

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1 The term "granite" (which is that used on the maps of the district by the old Geological Survey of Victoria) is here used as a broad field-name only.

which now run into the Yan Yean Reservoir, had their outlet. It will be noticed that in this locality the Plenty has a narrow north and south ridge on each side of it, and that on the opposite side of each ridge a stream runs parallel to the Plenty. The eastern stream runs into the Reservoir, and the western one turns towards the south-east to join the Plenty, which (judged by the line of outcrop of the silurian on its north-eastern side), it apparently did prior to the basalt flow.

A point in favour of the capture is the continuous basalt north of the Morang Hills, from the Plenty for several miles to the west, which might indicate an old valley and a swing round to the west of the old stream. But when it is remembered that whole ridges of low elevation must have been buried by the basalt, such a ridge, separating the tributaries of the old Plenty River and Merri Creek, may have existed here. If capture had taken place before the basalt was erupted, then part of the old Plenty south of the point of capture would be turned northward, and a low ridge separating such northward flow from the stream below might lie buried near Morang. So far as I am aware, nothing is known of the thickness of the basal in the main part of the valley at Morang, and farther north; so that this point cannot be proved or disproved at present. In addition the development of the old valley between Morang and the point of capture could not be accounted for (this northward stream being too short for such work), unless it be assumed that such development took place wholly before capture.

Without further consideration of the possible changes in the old Plenty, it is clear that when the newer basalt was poured out, a valley existed to the east of the Morang Hills, down which this basalt flowed; and meeting the flow from the west, spread out south of the Morang Hills into a broad sheet stretching to the west for several miles, and also to the south, partly filling the old valleys now occupied by the Darebin and Merri Creeks. The country to the east of this main sheet of newer basalt is more elevated than the latter (except between Janefield and Morang, where the different formations are on much the same level). This elevated country consists of older basalt, silurian, sandstones and shales, and tertiary grits and gravels, and its western boundary is really a continuation of the eastern side of the old Plenty valley

above Morang. It formed an almost complete barrier to the eastward spread of the newer basalt.

This barrier was penetrated between Morang and Janefield by two narrow tongues of basalt from the main mass, as shown on Quarter Sheet 2 S.E. These tongues give the key to the later history of the Plenty River. The accurate mapping of the district by Aplin suggested to me, before going over the ground, the solution of the problem. Both these tongues have a slope south-easterly into a pre-existing valley, which now forms the lower Plenty valley. From the main road to Whittlesea, at an elevation above sea level of about 500 feet, the southern tongue descends rapidly into the present valley. At its margin, close to the stream, its upper surface is about 170 feet below the main road level. This is not due to denudation, but represents with approximate truth the fall of the basalt flow. The softer silurian and tertiary rocks on each side of this tongue slope from the main road towards the Plenty at about the same angle as the basalt. These rocks are even now mostly higher than the basalt tongue, a fact which proves that the latter partly filled on old tributary valley of the stream which is now the Plenty.

The northern tongue shows similar features, but not so pronouncedly as the other, and it has apparently been more denuded; but still it is clear that it ran south-easterly down a small valley. (See Fig. 1, which is a diagrammatic section across the upper part of this tongue in Section VI., Parish of Morang.) The southern tongue is continued as a narrow strip not more than 30 feet in thickness down the right bank of the present Plenty valley, and getting deeper into such valley, until it ceases about a mile to the north of Greensborough. It no doubt extended farther than now mapped; but was becoming thinner, and part has been removed by denudation. Its upper surface is very even, and it undoubtedly represents the approximately original surface of the flow. This strip is now broken into sections by the short but steep gullies joining the Plenty from the west. The northern tongue was probably at one time continuous with the southern one; but river action has disconnected them.

At the end of the northern tongue of basalt, the lower surface of the latter is about 170 feet above the Plenty, and at the end of the

southern tongue about 100 feet above the same river. Where the Maroondah Aqueduct crosses the present Plenty (which is near the end of the narrow strip of basalt above mentioned) the lower surface of the basalt is about 60 feet above the stream and about 125 feet below the immediate top of the valley. (See Fig. 2, which is a diagrammatic section at the Maroondah Aqueduct.) From these measurements, and allowing also for the rise in the bed of the present Plenty, it can be seen that there is a rapid fall in the lower surface of the basalt between the northern tongue and the Maroondah Aqueduct. Where the valley rises above the level of the basalt flow, it is even now fairly undeveloped, especially towards the end of the narrow basaltic strip. It is clear, therefore, that the present Plenty valley from Morang southward existed before the flow of the newer basalt, as a young valley with a rapid fall. Since the lava stream, this valley has been re-excavated between the basalt and the other rocks, but to a much greater depth, and with an accentuation down to its mouth of its youthful character.

The conclusion is therefore reached that before the flow of the newer basalt, there existed a broad, moderately mature valley above Morang, and one indicative of youth below, which reverses the normal order, if it be assumed that these two valleys were then continuous. No satisfactory explanation can be given for this unusual deviation. If, however, the upper and lower valleys be regarded as originally distinct, then the observed facts become explicable; and the probable sequence of events may thus be stated. Before the flow of the newer basalt, the Plenty as a mature stream ran in a south-westerly direction from Morang,[1] having as the eastern side of its valley the more elevated land now forming the eastern border of the main basalt flow, as before noted. The present lower Plenty formed an independent stream, young and vigorous, with a steep grade and running in a south-easterly direction. It had eaten its way back towards the old Plenty valley, near Morang, and probably in time would have captured the head waters of the stream there.

1 If capture had taken place at the Barber's Creek Gap the streams would be altered, but the old valley at Morang remained. Such capture would not affect the present argument.

The head of this independent stream was probably forked, the prongs representing the small valleys occupied by the two tongues of newer basalt already mentioned. These small valleys had notched the ridge forming the eastern side of the old Plenty valley, the ridge itself probably being reduced by the proximity of two valleys, as commonly occurs. The newer basalt flowing down the old Plenty valley above Morang was, in comparison to the flow to the westward, south of the Morang Hills, cramped for room. It would thus tend to increase in height and bank itself against the bounding ridges. Tracing the eastern edge of the basalt northerly from about 1½ miles north of Bundoora to the head of the southern tongue of basalt, the country rises very rapidly. This is shown also by the heights recorded on Quarter Sheet 2 S.E. along the Yan Yean Reservoir Pipe Track, where a rise of 100 feet occurs in about a mile (340 feet to 440 feet). At South Morang Railway Station (about 2 miles from the 440 feet level), the height is 512 feet (a rise of 72 feet). Between here and South Yan Yean (3 miles) there is only an increase of 20 feet. The easterly tributaries of the old Plenty provided more room here.

Possibly the greatest check to the flow would be just to the south of Morang, where the basalt coming down the old Plenty valley would meet the main mass from the western side of the Morang Hills; and it is precisely at this point (as the heights above given show) that the greatest amount of ridging up has taken place. This ridging up was sufficiently high to enable the basalt to overflow at the two notches mentioned above, and to run down as two narrow tongues into the present lower valley of the Plenty; and thence continue as the narrow strip down such valley. After the basalt flow, the upper Plenty found its way and kept mainly to the junction of the basalt and the older rocks, and so worked its way down as far as Morang.

If the two tongues of basalt had not existed, in all probability the course of the river would have continued in a south-westerly direction, between the junction of the main basaltic mass and the older rocks to the east, and would have eventually entered the present Darebin Creek valley below

Bundoora, emptying itself into the Yarra, where that creek now enters. The lateral overflow of the basalt changed this. The stream naturally kept between the basalt and the silurian, and so entered the younger valley. Once there it retained its course, keeping the thin basaltic strip to the west, and excavating much more deeply than the level of the basalt. Hence the diversion of the upper Plenty waters through the Greensborough country to the Yarra to the west of Templestowe.

The fall of the narrow strip of basalt in the old independent stream has already been noticed. It is interesting to record the fall of the present river in various parts. Between Greensborough (river bed about 100 feet above sea-level) and the southern tongue of basalt already referred to (river bed about 200 feet above sea-level), a distance of over 3 miles, the fall would be about 30 feet per mile. Between this southern tongue and South Yan Yean (river bed about 500 feet above sea-level) a distance of about 5 miles, the fall would average about 60 feet per mile.[1] If a mile to the south of South Yan Yean be left out of the calculation. the fall would be greater, as the stream in this mile runs entirely through basalt and its valley is shallow (not more than 30 feet deep). When the basalt has been cut through and the softer silurian rocks met, erosion acts much more rapidly. About South Yan Yean the river continues in a very shallow valley, whose fall would approximate to that of the country through which it runs. Thus between South Yan Yean (532 feet) and Whittlesea (637 feet) a distance of about 6 miles, the difference in height is 105 feet, giving an average per mile of 17½ feet.

The figures quoted bring out two points very clearly. Firstly, the gentle grade of the valley, cut in a pre-existing one, as compared with the steep grade (once the basalt is cut through), where the river had to cut entirely afresh. This is what would be expected. Secondly, the wonderful power of resistance to denudation of the basalt, compared with the silurian sediments (although these in places are fairly hard rocks). Where the stream has not cut through the basalt into the underlying rocks, the valley is shallow and insignificant, but where such cutting has been done a deep gorge exists.

[1] Except the heights of railway stations and those mentioned on the Quarter Sheets those given in this part of the paper have been determined by aneroid.

The Probable Old Course of the Plenty.

It has already been remarked that, in the writer's opinion, the old course of the Plenty (now occupied by newer basalt) was originally to the east of the Morang Hills as far south as Morang, and then probably to the south-west. What the actual course was below Morang before the flow of the newer basalt can only be surmised. The lava has covered such a wide stretch of country to the west that the ridges and valleys have alike been covered up. That such ridges and valleys did exist is proved by the remnants of the ridges and valleys to the north and south of the main basaltic area. From the character of the exposed ridges and valleys, the covered ridges were probably broad, and the valleys comparatively narrow. The southern ends of the ridges, as at Preston and Essendon, are exposed, apparently, on account of the basalt thinning out in its flow southward. The northern outcrops, such as the Morang Hills (granite and indurated silurian), some isolated hills at Donnybrook (indurated silurian) and the hills at Broadmeadows (mainly granite) may be accounted for by the hardness of the rocks. They are probably residuals or monadnocks in the formation of the peneplain, out of which the old pre-newer-basaltic valleys have been carved.

Assuming that the old Plenty came down the Morang valley its most probable lower course would be either to the west of Preston down the old valley of the present Merri Creek, or down the old valley of the present lower Darebin Creek. The latter appears to be the more likely. If the Plenty ran south-westerly from Morang towards the Merri Creek valley, the old Darebin Creek valley would necessarily be short, but so broad that it would be out of proportion to its length. Moreover, the main mass of the newer basalt is bounded by a ridge from Morang to south of Bundoora, which suggests that such ridge formed the continuous eastern boundary of an old stream. For these reasons, the Darebin Creek valley is adopted as the original course of the Plenty. It may be noticed that the valley is narrow where the main road to Whittlesea crosses the Darebin Creek; but some very hard tertiary quartzites occur on the

eastern side, which will account for its contraction. This repeats a feature already noticed in the old valley at Morang, due to the hard granite and indurated silurian.

If the original Plenty followed the course suggested, its western. side was probably a low ridge connected with the Morang Hills, and the ridge of silurian and tertiary strata at Preston. This assumed part of the ridge is covered by newer basalt; and the question arises why such middle part should be covered and the ends exposed. The southern end is bare, probably on account of the basalt thinning out in its southward flow. A point would be reached where the valleys alone could receive the whole of the basaltic stream. As regards the Morang Hills, reference has already been made to the possibility of their upper portion forming a monadnock on the old peneplain. These hills towards their centre (where the granite and indurated silurian rocks occur) have a fairly even sky-line. To the north and south, this line drops rather suddenly, and in the south it quickly passes under the basalt. To the north, after the rapid drop, the lower part runs northerly as an even ridge of about the same height, or in the same line of slope, as the western ridge of the Plenty between Whittlesea and Yan Yean, with which it was at one time continuous. It is now broken by the Barber's Creek Gap. The height of this ridge near South Yan Yean (in section 2, Parish of Yan Yean) is about 700 feet above sea level. The top of the Morang Hills is probably at least 100 feet higher. If the 700 feet ridge be continued in a sloping line southward, it would meet at the southern end of the hills, the lower ridge which soon passes beneath the basalt. Thus if the upper part of the Morang Hills be treated as a monadnock, the discrepancy between their height and that of the assumed covered ridge to the south is somewhat explained. In any event, however, the hard rocks would ultimately tend to project above the surrounding softer ones. When it is remembered that the newer basalt was high enough to pierce the ridge forming the eastern boundary of the main basaltic mass, and that this ridge is protected by caps of older basalt, it is not difficult to believe that a ridge lies buried between the Morang Hills and Preston, especially if that ridge did not possess any hard rocks as a protection against denudation.

If the Plenty were captured at the Barber's Creek Gap before the flow of the newer basalt, its upper waters would be diverted into the old Merri Creek basin, but the original valley south-west of Morang would remain, carrying an independent stream until the newer basalt eruptions.

THE RELATIONS OF THE PLENTY AND YARRA RIVERS.

The old Plenty gives evidence of having been fairly well developed before the flow of the newer basalt; and from the width of the old Merri Creek valley, the same may be said of that. (From the geological maps, it seems probable that the old Merri Creek was joined by the old Moonee Ponds Creek). The Yarra for some distance above Templestowe has all the characters of a youthful valley, as Prof. Gregory has pointed out.[1] Between Templestowe and the mouth of the Darebin Creek, the river meanders through its own alluvium. Dr. Hall[2] has remarked that the newer basalt (down the Darebin Creek valley) checked the flow of the river above the Fairfield railway bridge, the effect of which was to build up a plain of sediment up the Yarra as far as Templestowe, and up the Plenty, where, a mile above its junction with the Yarra, the alluvium is 30 feet deep. The checking of this body of water would also cause the river to meander and so to widen its valley. It has similarly affected the Koonung Koonung Creek, although this is not shown on the geological maps. The effect of the basalt bar at Fairfield extends to the Plenty, and up that stream to some extent. As mentioned above, the upper Plenty waters were diverted at Morang by the newer basalt flow into the present Plenty channel. Hence practically at the same time the Yarra was checked at Fairfield, and a large additional volume of water from the upper Plenty basin was poured into the Yarra through the present Plenty mouth. This water, without the bar at Fairfield, would tend to widen the stream below its entry (if the stream were at or near its grade), and tend to a somewhat sharp disparity between the nature of the valley above and below the mouth of the present Plenty. It would be accentuated by the basalt at Fairfield, and in this way the existing conditions have arisen. The limitation of the alluvial flats up

1 Ib., pp. 106 and 107.

2 Victorian Hill and Dale (1909), p. 42.

stream, the wide mouth of the Plenty valley and the extension of the alluvium up that valley, are partly explained by the diversion of the Plenty waters from above Morang.

From these circumstances it may be inferred that the Yarra valley was, at the time of the newer basalt flow, as far as its junction with the old Plenty valley (the Darebin Creek valley) similar to that now above Templestowe, and hence a young valley. The old Plenty[1] and the old Merri Creek were, judged by their valleys, apparently more developed than the Yarra. The latter stream probably joined the old Plenty near Fairfield, which in turn would join the old Merri Creek at Clifton Hill. The combined streams would then flow down the valley of Collingwood and Richmond (now occupied by the newer basalt) to Melbourne. At this time the Yarra could not, perhaps, from its stage of development, be regarded as the main stream. With the diversion of the upper Plenty waters, however, consequent on the eruptions of the newer basalt, the old Plenty valley received only the small Darebin Creek; but even this was turned into the Yarra above the basalt. The Yarra also received the whole of the water from the present Plenty basin. It thus gained increased erosive power, which enabled it to cut its channel below Fairfield much faster than its only rival, the present Merri Creek (the drainage area of which, since the flow of the newer basalt, is much less than formerly, if, as suggested above, the old Moonee Ponds Creek once joined it); and so the Yarra became the predominant stream.

Summary.

The Plenty River originally passed down the Morang valley, and from Morang probably ran south-westerly and southerly into what is now the Darebin Creek valley. This old Plenty valley was fairly well developed before the newer basalt flow.

The possibility of changes in the course of this stream before the eruption of the newer basalt is indicated.

The present Plenty below Morang was originally an independent young stream, with its heads near Morang, and with a steeper fall than at present.

1 The stream referred to here and shown as an old river on the accompanying map is what is mentioned above as the original Plenty. If capture had taken place at the Barber's Creek Gap, of course the remaining stream down the lower part of the original Plenty valley would be much reduced.

The newer basalt obliterated most of the old Plenty, and overflowed the heads of the independent valley by two small tongues of basalt. By means of these tongues, the upper Plenty waters were diverted to the south-east into the independent valley, which has since been more deeply cut into. The old valley above Morang has been deeply re-excavated.

The newer basalt covered some of the ridges as well as the valleys, and so largely obliterated traces of the old streams; but despite this, the basalt flows are invaluable for tracking these earlier streams.

The striking difference in the power of resistance to erosion between the newer basalt and the silurian sediments, is indicated by a comparison of the grades of the present Plenty above and below the point where the stream has cut through the basalt into the silurian.

The effect on hard rocks is also shown at Morang, where, through the delay in cutting through such rocks, the old stream formed a wide open valley above.

The tops of the Morang Hills and of other high points are suggested as monadnocks on the peneplain out of which the Plenty was originally carved.

The diversion of the upper Plenty waters at Morang in consequence of the newer basalt flow, has accentuated the lateral erosion of the Yarra between Fairfield and Templestowe.

The Yarra was probably less developed prior to the newer basalt eruptions than the old Plenty River and Merri Creek, and perhaps, judged from that standpoint, could not be regarded as the main stream; but since then it has become the predominant river.

ANDERSON'S CREEK, WARRANDYTE.

From almost any of the higher view-points at Warrandyte, the tops of the hills and ridges can be seen stretching away in so even a line that there can be no doubt that they are the remnants of an old peneplain, the highest points of which (in the immediate neighbourhood of Warrandyte) are probably about 450 feet[1] above sea-level. This peneplain has, since its

1 All the heights mentioned in this part of the paper are based on aneroid readings.

uplift, been deeply but not maturely dissected. Vertical erosion has been extremely active; but lateral erosion has not progressed very far. The country, therefore, is broken into a series of narrow and steep valleys and sharp ridges. The principal stream is the Yarra, which is here confined to a narrow valley. The township of Warrandyte lies on the southern side of the river; and at its western end, Anderson's Creek enters the Yarra from the south, while at the eastern end, Parson's Gully joins the same main river. It is with the relations between Anderson's Creek and Parson's Gully that this paper is concerned; and therefore some remarks on the directions and positions of these valleys will be offered.

Anderson's Creek rises a little to the north of Ringwood. It consists here of two small creeks, which soon unite; and the resulting stream then runs in a direction a little west of north until it approaches the western head of Parson's Gully, when it turns more to the west, and so continues until joined by Harris's Gully from the south. It then runs northerly to the Yarra. Although Anderson's Creek along its whole course is essentially a young stream, this feature is more marked in that portion between the turn near Parson's Gully and its junction with Harris's Gully. The part mentioned is a deep gorge, and contrasts with the other more open divisions of the valley. The best view, perhaps, of the gorge (which it is convenient to refer to as the "Anderson's Creek Gorge") is from the southern end of Fourth Hill, where it is about 300 feet in depth.

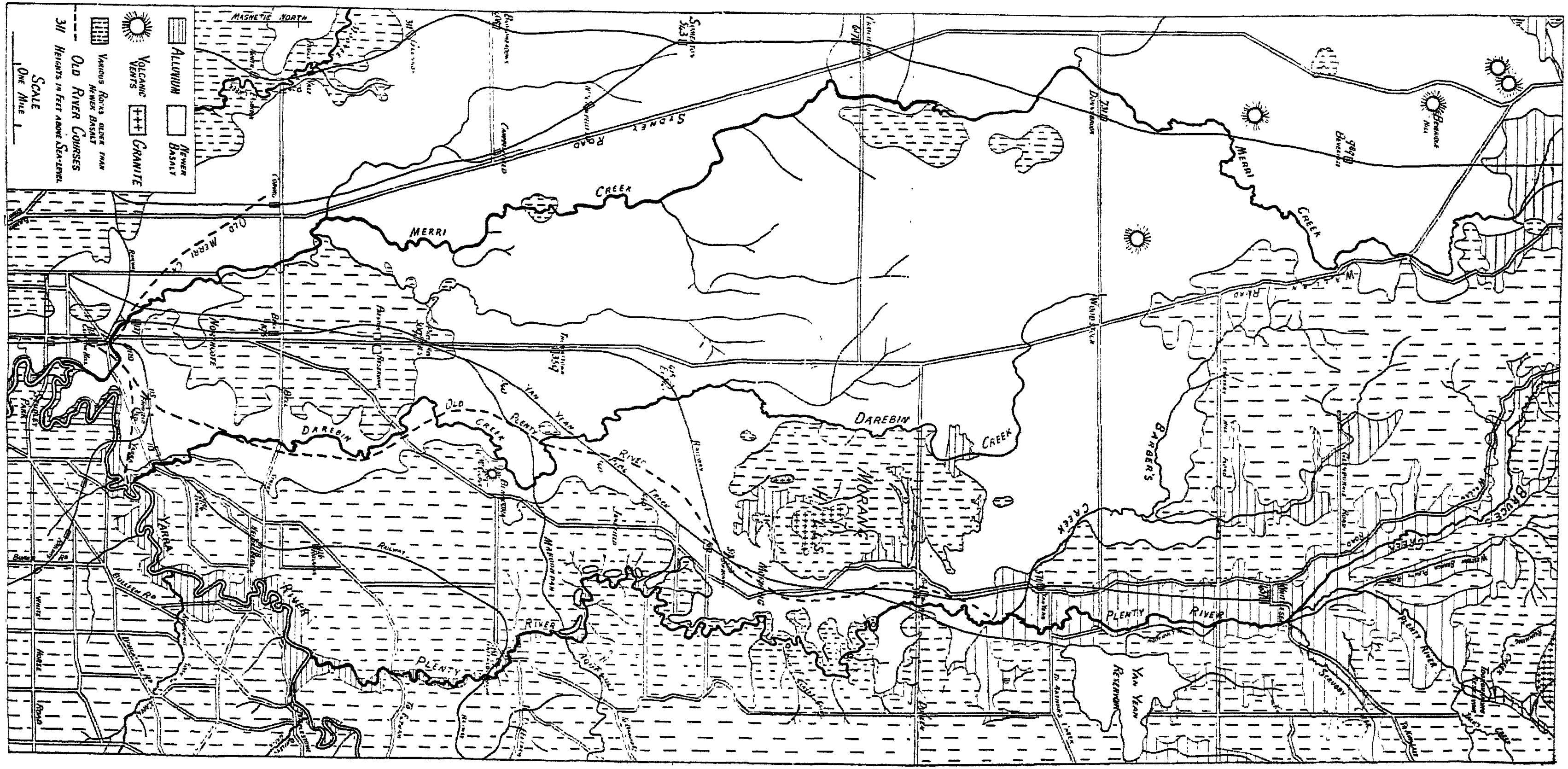
Parson's Gully is less in length than Anderson's Creek, as the accompanying map indicates. Its head is forked, the eastern prong of the fork being nearly a mile, while the western one is about a quarter of a mile in length. The western prong is close to the entrance to the Anderson's Creek Gorge. Parson's Gully is a fairly broad, open valley, different from Anderson's Creek Gorge, but resembling in general characters the upper and lower parts of Anderson's Creek. The main road from Warrandyte to Ringwood runs through the valley of Parson's Gully as far as its western head, when it crosses into the valley of the upper Anderson's Creek. Harris's Gully is similar in character to Parson's Gully, but not so broad and well developed, although of greater length. All the valleys mentioned are deeply trenched in the peneplain.

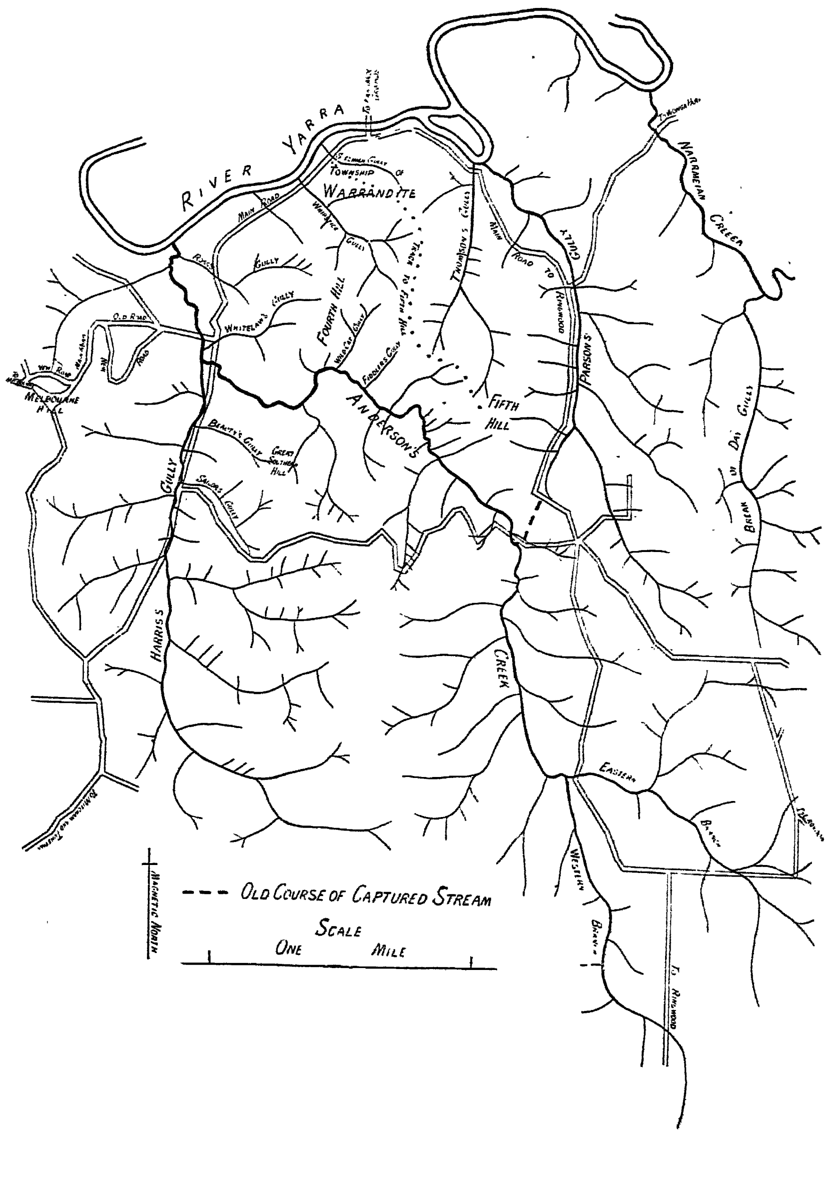
The Warrandyte goldfield is mainly confined to the area of country bounded by the Yarra River, Anderson's Creek and Parson's Gully. (Reefs extend beyond these boundaries, but are not too plentiful.) The cause of this I hope to explain in a later paper. For the present, it will suffice to note the fact. The rocks of this area are of silurian age, and consist in part of coarse sandstones, grits and conglomerates. Quartz in the form of reefs and veins, filling joints and others fissures, is widespread and abundant. By its injection the rocks have become hardened and more resistant to denudation. The conglomerates, grits and coarse sandstones, and, apparently, also the quartz reefs, gradually die out south of the Anderson's Creek Gorge; but the latter is not the actual boundary of the reefs or of the hard rocks. This is well shown by the Great Southern Hill, which forms the continuation of the ridge known as Fourth Hill on the northern side of the gorge. This ridge forms the crest of an anticline, and the effect of the hard rocks of the Great Southern Hill is well illustrated in the small gully known as Beauty's Gully, which runs eastward from its mouth in an almost level line till it meets the ridge, when it sharply rises. To the south of Beauty's Gully other easterly tributary gullies of Harris's Gully extend much farther to the east, on account, no doubt, of the rocks there being softer.

To the east and west of Parson's and Harris's Gullies respectively, the conglomerates, grits and thick sandstones together with the quartz reefs, practically disappear. The rocks consist mainly of shales, and are therefore softer and liable to more rapid denudation than the coarser-grained silicified rocks of the Warrandyte goldfield area. Here again the effect of the hard rocks may be seen in Parson's Gully. On its western side the tributary gullies are short and steep, whilst on the eastern side they are long and well graded. The strike of the silurian rocks of the district is a few degrees to the east of north. The directions of Parson's Gully, Harris's Gully, and the upper and lower Anderson's Creek approximate towards the strike of the rocks, while Anderson's Creek Gorge cuts across both the strike and some of the hardest rocks. Parson's Gully and the upper part of Anderson's Creek on the eastern side, and Harris's Gully and the lower part of Ander-

son's Creek on the western side of the goldfield area, run approximately parallel to one another. Fifth Hill, a high point on the old peneplain at the entrance of Anderson's Creek Gorge, is about 270 feet above the bed of the stream. The western head of Parson's Gully is separated from the gorge by a low ridge, the latter being about 170 feet below the top of Fifth Hill, and is therefore about 100 feet above the bed of the Anderson's Creek Gorge. This ridge is continued as a shelf in Anderson's Creek valley, above the gorge, and also in Parson's Gully, on the eastern side of the latter valley. In this shelf Anderson's Creek has cut a narrow, steep valley; and Parson's Gully and its tributaries have also somewhat dissected it. The connecting low ridge itself has practically not been cut into.

All these facts seem to point to the following conclusions:—At the uplift of the peneplain, the natural drainage lines would appear to have been along Harris's Gully and its continuation (the lower part of Anderson's Creek), on the western side; and the upper part of Anderson's Creek and its continuation (the present Parson's Gully) on the eastern side. The harder ground between would be avoided as far as possible. The two streams would be independent of one another. Tributaries on each side of both streams would, of course, be formed as the main streams graded their channels. One of such tributaries of Harris's Gully apparently flowed westerly from the divide between the two main streams along the course now occupied by the lower part of the Anderson's Creek Gorge. This tributary would have difficulty in cutting through the hard rocks of the goldfield, but its grade would be steep, and this, aided by some faulting which has probably taken place along part of the line of its valley, would cause rapid vertical erosion and form a deep gorge. Gradually eating its way backward, this tributary appears to have eventually reached the eastern main stream, and to have captured its upper waters when the valley of this eastern main stream was not lower than the reduced ridge previously referred to close to the Ringwood Road. By this capture, the tributary became the main stream of the district, the present Anderson's Creek. Harris's Gully, which was formerly the main western valley, became subordinate to the tributary, and the old eastern stream was reduced to the present Parson's Gully, occupying


Alluvium
Newer Basalt
Volcanic Vents
Granite
Various Rocks older than Newer Basalt
Old River Courses
311 Heights in Feet above Sea-level
Scale
One Mile
Magnetic North
Merri Creek
Sydney Road
Old Merri Ck.
Darebin Creek
Old Plenty Creek
Plenty River
Yarra
Yan Yean Reservoir
Yan Yean
Barber's Creek
Morang Hills
Northcote
Whittlesea
Railway
Bulleen Rd.
White Horse Road


River Yarra
Township of
Warrandite
Main Road
Fourth Hill
Fifth Hill
Anderson's
Thomson's Gully
Parson's Gully
Main Road to Ringwood
Narrneian Creek
Harris's Gully
Whitelaw's Gully
Beauty's Gully
Great Southern Hill
Sailors Gully
Fiddlers Gully
Wildcat Gully
Track to Fifth Hill
Old Road
Melbourne Hill
Creek
Eastern Branch
Western Branch
To Ringwood
Magnetic North
Old Course of Captured Stream
Scale
One Mile

a valley too broad in proportion to its length. The low ridge between the western end of Parson's Gully and the Anderson's Creek Gorge represents the approximate level of the valley when the upper part of Anderson's Creek and Parson's Gully were one continuous stream; and the height of this ridge above the present Anderson's Creek (about 100 feet) represents the minimum vertical erosion since the capture. It is somewhat difficult to fully understand why the capturing stream should so successfully have crossed the hard rocks, but on the other hand the low ridge near the entrance to the gorge, and the other facts mentioned, can only be satisfactorily accounted for by the explanation given above.

Various points on Fifth Hill give excellent views of the gorge, and of the once continuous valley to the north and south.

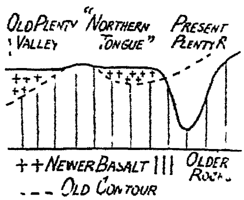


Fig 1

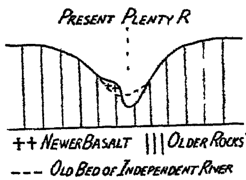


Fig 2

EXPLANATION OF PLATES.

Plate XXXI

Map compiled from the Geological Survey Quarter Sheets of the district, with some later topographical information. The rocks older than the newer basalt have for the purposes of the paper been grouped together. The numerals indicate the heights of some railway stations and points along the Yan Yean Pipe Track. The unshaded portions represents the newer basalt (except the Yan Yean and Toorourrong Reservoirs, which occur in silurian country).

Plate XXXII.

Sketch map of the Warrandyte district, compiled partly from Quarter Sheet 40 N.W.

[PROC. ROY. SOC. VICTORIA, 22 (N.S.), PT. II., 1909.]

ART. XIII.—*The Building Stones of Victoria.*

PART I.—THE SANDSTONES.

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(With Plates XXXIII.-XXXVI).

[Read 9th December, 1909].

INTRODUCTION.

Although Victoria is a country rich in various mineral deposits, it has not up to the present yielded a sandstone with properties which have rendered its adoption to any extent for building purposes. The want of a good cheap Victorian free-stone is at present severely felt by Melbourne architects, and although many stones have been tried at different times in Melbourne, one having the combination of good weathering and economical dressing properties has not been obtained.

For many years thorough investigations into the weathering properties of building stones have been carried out in America and Germany, but in Victoria very little appears to have been done in this direction.

In the early sixties J. G. Knight[1] carried out investigations on several Australian stones then used; while some of his results still hold, much of it, more especially the chemical portion, is almost valueless. In 1873 a Board was appointed to examine and report on suitable stone for the erection of the Houses of Parliament; their report was submitted early in 1879, and then, as now, the difficulty of finding a cheap and good weathering stone was very pronounced. The stone eventually chosen for the Houses of Parliament was that from the Grampian quarries, 17 miles north-west from Stawell. It is the

1 Australian Building Stones, 1864.

sandstone with the best weathering properties which Victoria has produced, but on account of its cost in dressing, is in most cases prohibitive to the private individual.

In the early building days of Melbourne, Tasmanian sandstones were extensively used, and at the present time, in buildings other than public ones, little else than Sydney stone is used, while all along Victorian sandstones have been adopted only to a small extent.

Of recent years the methods of testing stones for building purposes have been greatly improved, and since the advent of the microscope much more has been learnt about the constitution and the minerals in the stones, so that by its use in conjunction with the other tests, much more can be concluded from laboratory experiments than was the case previously.

In view of all this, it was felt that an investigation on a thoroughly scientific basis would yield results of value both to the quarry owner and the architect, and as a result this work was entered upon.

Sandstones.

The following Victorian sandstones have been dealt with:—

1. Stawell.
2. Dunkeld.
3. Barrabool Hills.
4. Apollo Bay.
5. Bacchus Marsh.
6. Darley.
7. Egerton—both fine and coarse.
8. Greendale.

GENERAL DESCRIPTION.

Stawell Stone.

This is a fine, even grained, white sandstone, quarried at the foot of the Grampian Ranges, 17 miles north-west of Stawell. It is a very hard and compact stone, probably of carboniferous age, shows very little bedding in the fresh state, and is remarkably free from ironstaining.

In places the stone has abundant segregations and veins of secondary silica termed "flints" by the masons. The initial hardness of the stone, together with the presence of these flints, renders the stone a very expensive one to dress. The beds, which are thick, dip into the hillside at about 45 degrees in a westerly direction. Stones of any size in reason are obtainable, and the quality seems fairly uniform throughout the quarry.

Current bedding exists in the stone to a large extent, and although it does not appear in the freshly quarried or dressed stone an examination of the weathered material detects it, owing to the slight inequality in hardness of the different layers. A small quarry has been opened up by Robson and Gray a little to the south of the main quarry, but the stone therein is more ironstained than in the large quarry, and some difficulty has been experienced in obtaining a good "back." This so-called "brown stone" is finding a ready sale for pitcher-making, and is being extensively used in many places for this purpose.

The stone was used in the Stawell Town Hall when the quarries were first opened up, but much of the surface material was differentially iron-stained. For this reason alone, and not on account of its weathering away, the stone in the Town Hall was painted in after years. The Stawell Court House, built in 1879, is a splendid example of the weathering properties of this stone, and to-day looks almost as fresh as newly-quarried stone, being especially clean looking in contrast with the dirty appearance the stone takes on in Melbourne after a time, due to the deposition of sooty and tarry material.

Buildings of this stone in Melbourne are Parliament House, the Crown Solicitor's Office, the recent additions to the National Museum, the upper portions and recent additions to the General Post Office and Town Hall.

Dunkeld Stone.

This is a fine even-grained sandstone, with a light brownish tint, and well defined bedding planes. It is quarried on the slopes of Mt. Abrupt, three miles from Dunkeld, at the southern end of the Grampian Range, about 40 miles due south of the Stawell quarries.

This stone forms part of the same series of sandstones[1] as the Stawell stone, and is probably of carboniferous age.

The quarry, although opened up in 1860, has not been extensively worked, and a lot of dead work has been done owing to bad iron-staining and to a large fault. The beds dip west, at about fifteen degrees into the hill, away from the quarry, which is situated on the opposite side of the Wannon River from Dunkeld; with the result that the cost with the present system of carriage is increased. The cost of dressing this stone is about 20 per cent. less than Stawell stone, but it has not the uniform colour of the latter. Up to the present none of the troublesome "flints" of the Stawell stone have been encountered, but "sand-balls," generally along the bedding planes, are met with

Occasionally, hard, flinty bands up to an inch or two in thickness and generally more ironstained than the surrounding stone are met with, but these can be avoided. A marked defect of this stone is the current or false bedding, which becomes most pronounced on weathering, and may be seen very well in the stone used in the recent additions to the Women's Hospital, Carlton. Between the layers a fine argillaceous powder is present, which falls away readily on weathering. This, together with the differential ironstaining of the layers, gives the stone after being in a building a very short time a bad appearance. This stone has not been used to any extent, but may be seen in the Hospital mentioned above, and in the Presbyterian Church, Hamilton.

Barrabool Hills Stone.

This is a fine, even-grained sandstone, of a light green-brown colour. It is quarried in the vicinity of Ceres, among the Barrabool Hills, near Geelong. It is of Jurassic age, and forms part of the widely distributed series of lake sandstones laid down during Jurassic times. The stone is of fresh water origin, and is made up largely of igneous material containing carbonaceous inclusions in the way of leaves and stems of ferns and other plants.

Its weathering properties are variable for different quarries, but the samples investigated were obtained from McCann's

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1 Krausé. Progress Report, No. 1, Geol. Survey Vict., p. 130.

quarry at Ceres, and which is generally regarded as producing the best stone.

The bedding is difficult to discern when freshly dressed, with the result that in many of the older buildings it has been used with the bedding vertical, thus leading of course to disastrous results. The stone is fairly uniform in colour, though gradations to the bluish-grey colour of the stone in its unaltered state are discernible. Bands of grit occur here and there through the stone, which is almost horizontally bedded in the above quarry.

This stone, which is a soft one, and dresses easily, though rather treacherous, has been used extensively in Geelong and other places. When rough dressed it weathers better than when smooth-dressed, as in the latter case it has a tendency to flake off on weathering, due to a disturbance of the particles near the surface of the stone during dressing operations.

An examination of the Geelong structures of this stone gives a good idea of its weathering properties, as some of them have been erected for about fifty years—e.g., the Art Gallery in Moorabool-street. The stone breaks away at the corners, and flakes along the edge, more especially if in a damp situation, with the result that these older buildings have to be continually repaired and patched with cement.

The stones crack easily, especially those over the windows, for quite large stones which one would expect to stand the pressure, easily develop dangerous cracks.

In other stones wind erosion effects are most pronounced if the stone is at all gritty, the harder parts standing out like pimples. The Old Police Court, at the corner of Russell and Latrobe streets, Melbourne, was built with this stone in 1842, and here one sees how stone may decay, for nearly all the stones are in a most rotten condition, and many of them could be crumbled in the hand. Other structures in Melbourne of this stone are St. Paul's Cathedral, which is showing very evident signs of decay in many places; Scots' Church, the Working Men's College, Ormond College, and the Biology and Medical Schools at the University. In many of the buildings of this stone in Melbourne the gables come away from the main structure to the extent of one or two inches after a time; some light

may be thrown on this movement by the results in the following tests on the stone.

Apollo Bay Stone.

This is similar to the Barrabool Hills stone, with the exception that it is fresher and has a bluish-grey colour. It is of Jurassic age, and outcrops all along the coast in the neighbourhood of Apollo Bay, the quarry being situated right on the coast. The overburden is small, and even just below the capping the stone is remarkably fresh. Some stone quarried about fifteen years and which has been exposed to all weathers, is in a good condition, having weathered excellently. There is a fading in colour, but this is very little more pronounced than that which takes place after three or four years' exposure.

Blocks of any size within reason are obtainable, and the stone has the advantage of working very freely and dressing well.

It has not been used to any extent, but may be seen in the Cape Otway lighthouse, built many years ago, and also in the recently built Windsor Exchange.

Bacchus Marsh Stone.

This is a soft, even-grained sandstone of light brown colour. It is not at all a compact stone, and is unevenly ironstained. It is quarried at Bald Hill, about three miles from Bacchus Marsh, and has been used largely in that district. The stone is the well-known Bacchus Marsh sandstone of Permo-Carboniferous age. An examination of the quarry shows that it is anything but uniform in hardness, and also in quarrying a large amount of waste material is produced. This stone has been used in the Treasury Building, Spring-street, Melbourne, but has not stood at all well, many of the blocks being so rotten as to cause their replacement some little time ago. Several structures of this stone in Bacchus Marsh exist, but in every case, with the exception of the Church of England, the stone is in a very bad state. In the latter building the stones are rough dressed, but very uneven in colour.

Darley Stone.

This is a very soft, fine-grained sandstone, of a light buff colour. The quarries are situated about six miles from Bacchus Marsh, on Goodman's Creek, near Coimaidai. Several small quarries exist, but in all the stone is of a very poor quality, weathering away rapidly, as shown by the blocks about the quarries. The samples on which these investigations were carried out were obtained from Cosgrove's quarry. This stone has been used in the Parliamentary Library—lower portion—and in the Treasury, to replace the weathered Bacchus Marsh stone, but in both cases it has crumbled away badly.

Egerton Stone.

Fine-grained.—This is a fine-grained white sandstone of a very clean appearance, and dresses well. It is not quite uniform in hardness, due to the presence of thin hard layers here and there through the stone, and is slightly discoloured in parts by ironstaining.

Coarse-grained.—This is considerably coarser than the above stone, but also dresses well and works easily. It exhibits a well-defined bedding plane, due to slight differences in the size of the grains in the different layers. In appearance it very much resembles the freshly quarried Sydney sandstone, is very friable, and must be regarded as a soft sandstone.

Both the stones are obtained from the same deposit on the east bank of the Moorabool River, near Egerton. The deposits —which consist of sandstones of Ordovician age—are tilted almost vertically, and strike north and south. One can obtain every gradation, from the fine to the coarse stone, but at one point there is a good thickness of fine, compact stone, of uniform grain and colour. This patch was worked a little, some sixty years ago, to obtain material for a house in the neighbourhood, and the weathering of the stone in this structure is excellent.

Greendale Stone.

This is a coarse-grained, light-coloured sandstone of good appearance, and is made up of sand grains and occasional

pale green patches of shaley material in lenticular masses, bound together by a whitish cementing material uniformly speckled with iron oxide. The stone is friable, and works very easily, but needs care in dressing. From samples the stone seems uniform in hardness and colouring, but the author has not visited the quarry, which is a few miles from Ballan, and nothing is known of its weathering properties in buildings.

It should be mentioned that all these stones, after being quarried or dressed, get a thin skin or coating of harder material all over them. This is more pronounced in the Bacchus Marsh, Darley, Egerton and Greendale stones than in the others, and is produced by the percolation of the "sap" water to the surface, and there evaporating, leaves the dissolved material in the form of a thin hard skin.

METHODS OF TESTING.

The determination of the actual qualities of a stone, good or bad, by laboratory tests, is exceedingly difficult. As the object of many of the tests conducted in the laboratory is to produce the same effects in a few days as are produced in as many or more years under normal weathering conditions, a great deal depends on the methods adopted. However, if all the stones are uniformly treated by these methods, which must necessarily be arbitrary, one obtains at least comparative results, and the relation which one stone bears to another is derived. Stones of known weathering properties, either good or bad, may form part of the series uniformly treated, and the relations which the unknown stones bear to the known ones will give a fairly accurate idea of the durability of the former. Unfortunately, the methods adopted in the laboratory are not the same in all countries, although steps are being taken by an International Congress to fix standard tests.

In the main the tests applied by the author are those followed by G. P. Merrill,[1] of Washington, U.S.A.

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1 Merrill. "Stones for Building and Decoration."

TESTS.

The following investigations were carried out on all the sandstones:—

1. To ascertain the specific gravity.
2. To ascertain the resistance to crushing.
3. To ascertain the absorptive powers.
4. To ascertain the resistance to corrosion.
5. To ascertain the resistance to mineral acids.
6. Microscopical examination.
7. Chemical analysis.

There are several other tests regularly conducted on building stones, but these were not included for various reasons. While a knowledge of the resistance to freezing is of supreme importance in many places, fortunately in Melbourne it is not so, as this city is almost free from frost, also the difficulty of obtaining anything like reliable results is very great.

The resistance of a stone to abrasion by wind-blown particles is rather important in Melbourne, but the difficulty of getting reliable results and the lack of opportunity for carrying out the test led to its non-inclusion.

1.—*Specific Gravity.*

Pieces of the stones were carefully dried at 110 degrees C., weighed in air when cold, and then suspended in water and there weighed. From the two weights the specific gravity was determined.

The specific gravity is of value in indicating which stones are liable to be the most absorptive, for with stones of the same mineral composition the one with the highest specific gravity is generally the least absorptive and so the most durable.

Several determinations were carried out on each stone, and the results appended below are the means of these. From the specific gravities the weight per cubic foot of these stones has been determined. With porous stones like these sandstones, the determination of the true specific gravity is a matter of some little difficulty, especially in obtaining the correct weight of the stone when suspended in water.

The Sydney stone has been inserted for comparison.

TABLE OF SPECIFIC GRAVITIES AND WEIGHTS PER CUBIC FOOT.

Stone	Specific Gravity	Weight per Cubic Foot, in lbs.
Stawell	2.371	148
Dunkeld	2.324	145
Barrabool Hills	2.144	134
Apollo Bay	2.335	146
Bacchus Marsh	2.081	130
Darley	2.043	128
Egerton (fine)	2.114	132
Egerton (coarse)	2.039	128
Greendale	2.164	135
Sydney	2.303	144

Most of the stones are light. This is due to their high porosity as shown later on by their absorption values. The most compact one is that from Stawell, and it is also the least porous.

2.—*Resistance to Crushing.*

These compression tests have been carried out on the testing-machine at the Engineering School, University of Melbourne, by Mr. James Mann, and I am indebted to Acting-Professor Higgins for their inclusion here. This test is the one most commonly conducted on building stones, but its value lies more in giving an indication of the adherence of the particles in the stone, and so a measure of the stone's durability, than whether it is strong enough, as only in exceptional cases with ordinary building stones does the load approach the safety value. Most of these tests have been conducted on 3-inch cubes, or thereabouts, in the usual manner, and the Sydney sandstone is again inserted for comparison. Merrill[1] states that no fair comparison of the crushing strengths of stone can be made except between results obtained during a single series of tests. However, the values in the accompanying tables have all been obtained in a uniform manner by the same operator, and can reasonably be assumed to be fairly comparative amongst themselves.

1 Stones for Building and Decoration, p. 497.

A perusal of the tables shows that the stones with the best weathering properties are the most resistant to compression, and that probably the poorest building stone in the list—viz., the Darley, also has the lowest compression value.

The Stawell stone gives remarkably high results, exceeding those of many granites. The Apollo Bay stone gives a good value, and this seems quite in keeping with its resistance to weathering. The Sydney stone comes next, with the Dunkeld a little below it.

The Barrabool Hills stone gives a low value, and from the manner in which it weathers can be considered only a fair stone. With regard to both the Bacchus Marsh and Darley stones, both give very low values, quite consistent with their durability, as seen in Bacchus Marsh and in Melbourne.

The fine-grained Egerton stone value is fair, and from what is known the stone weathers well. The other values are low, but nothing is known of their weathering properties in buildings.

TABLE OF COMPRESSION TESTS.

Stone	Size of Cube in inches	Total strength in lbs.	Strength in lbs. per square inch
Stawell	3	101.300*	11.255
,,	2	70.200	17.550
,,	2	70.000	17.500
Dunkeld	3	50.750	5.640‡
,,	3	39.250	4.360‡
Barrabool Hills	3	29.670	3.297
,, ,,	3†	26.500	3.195
Apollo Bay	3	61,500	6.833
,,	3†	73.900	7.866
Bacchus Marsh	3	17.750	1.940
Darley	3	10.300	1.144
Egerton (fine)	3	38.600	4.288
Egerton (coarse)	3	18.300	2.033‡
,, ,,	3	27.300	3.033‡
Greendale	3	21.600	2.400
Sydney	3	66.300	7.366
,,	3	43.200	4.800

* Crack at 90.000 † Approx. ‡ Perp. to bed.

3.—*Absorption.*

This test is one of the most important, especially with sandstones, but the chemical and physical natures of the stone must be considered as well as the absorption in ascertaining its durability.

There are several methods of determining this factor, but the simplest one has been adopted—that of total immersion in water till the stone is thoroughly saturated.

Two-inch cubes, with faces smooth dressed, were used. These were first thoroughly dried, weighed, and then placed in wide glass beakers, covered with distilled water, and allowed to remain there for four days, which time was found sufficient for the complete saturation of all the stones treated. The cubes were then carefully removed, the surface water absorbed by blotting paper, and then weighed with the least possible delay. The increase in weight gives the amount of water absorbed. If this be multiplied by the specific gravity of the stone, it gives the bulk absorption, or the weight of stone which would occupy the same space as the absorbed water does, and so the porosity. In all cases several determinations were made, and in the accompanying table are the means of these values. There is a great variation in the absorption of the different stones, for the Bacchus Marsh is three times as porous as the Stawell stone. The Stawell and Dunkeld stones are the least porous by a considerable extent, while the others, with the exception of the Apollo Bay stone, may be considered high, more especially that from Bacchus Marsh. The freezing of absorbed water is a very large factor in the disintegration of stones, and as a rule the value of a sandstone is the inverse of its absorption.

In Melbourne, owing to its small amount of frost, these high absorptions are not of so much importance as they would be in less favourable climates, but it must be remembered that the more porous the stone the more accessible are its alterable constituents to the destroying elements. The Stawell value is low, but this is to be expected from the physical and chemical nature of the stone. The Dunkeld and Sydney percentages may be regarded as fair, while the Apollo Bay stone gives a rather high value. All the others are high, more especially the Bacchus Marsh value.

From a microscopical examination of thin sections of these sandstones, the relative absorbent values may be determined, particularly for the Bacchus Marsh, Darley, Egerton and Greendale stones, as the amount of water absorbed varies almost directly as the amount of fine-grained cementing matrix in the stones.

Unfortunately, the matrix is of an argillaceous character, so that the high absorptions of these stones especially, must be regarded as detrimental.

TABLE OF ABSORPTIONS IN PERCENTAGES.

Stone	Absorption by weight	Absorption by bulk
Stawell	2.38	5.64
Dunkeld	3.41	7.92
Barrabool Hills	7.68	16.46
Apollo Bay	4.49	10.48
Bacchus Marsh	8.70	18.10
Darley	7.40	15.12
Egerton (fine)	6.93	14.65
Egerton (coarse)	6.54	13.33
Greendale	7.74	16.75
Sydney	3.65	8.40

4.—*Resistance to Corrosion.*

The object of this test is to find out the effect on the stones, of water containing carbon-dioxide in solution. Carbon-dioxide occurs to the extent of about .04 per cent. in Melbourne air. Rain water, carrying it in solution, is capable of dissolving calcium, magnesium, and iron carbonates, so that any stones containing these are affected by it. Limestones of course are more severely acted on than other stones, but sandstones containing these minerals are also affected.

Two-inch cubes, smoothly dressed were thoroughly dried at 110 degrees C., cooled, weighed, and immersed in water, through which a current of washed carbon dioxide was passed continuously for three weeks. Precautions were adopted to keep a quantity of the gas in contact with the water, so that it was kept thoroughly saturated, and the water was changed every few days.

Along with the sandstones was placed a cube of Carrara marble for comparison.

At the end of the time the cubes were carefully removed, dried for many hours at 110 degrees C., and then weighed, the difference between the two weights being due to the action of the carbonated water.

All the stones, with the exception of those from Barrabool Hills and Apollo Bay, lost weight. The Darley stone, known to contain a large percentage of carbonate, lost as much as 2 per cent., while the marble lost 1.8 per cent. In the case of the Darley sandstone, one is dealing with a porous stone, where the solution can percolate all through, while with the marble, which has a very low absorption (.18 per cent. by weight) the action is almost entirely confined to the surface. The Darley stone also lost some weight through some of the grains falling away, when the cement was weakened by the solution of the carbonate. The action on the marble was sufficient to remove a film nearly .2 mm. in thickness from the whole surface of the stone, with the exception of the thin carbonaceous veins, which stood out as ridges. The effect on the Apollo Bay stone was to give it a lighter colour, much the same as is produced by a few years' weathering. With regard to the other stones little or no change was noticeable in appearance. The amounts lost by the Sydney, Dunkeld, Stawell and Egerton stones is scarcely appreciable, whereas the marble, Bacchus Marsh and Darley stones all lost considerable amounts, due to the carbonates therein. The increase in weight of the Barrabool Hills and Apollo Bay stones is probably due to the presence of ferrous iron in the stones, which becomes oxidised.

TABLE OF PERCENTAGE LOSSES BY CORROSION.

Stone	Weight lost in percentage
Stawell - - - -	0.06
Dunkeld - - - -	0.01
Barrabool Hills - - -	0.17*
Apollo Bay - - -	0.15*
Bacchus Marsh - - -	0.38
Darley - - - -	2.01
Egerton (fine) - - -	0.00
Egerton (coarse) - - -	0.02
Carrara Marble - - -	1.79
Sydney - - -	0.03

* Denotes Percentage gained.

5.—*Resistance to Acids.*

Ordinary city air contains small percentages of hydrochloric, sulphuric, sulphurous, and nitric acids; of these the hydrochloric and sulphuric are the most important.

A solution containing 1 per cent, of each of these acids was made up, and smoothly dressed two-inch cubes, after being dried at 110 degrees C., cooled and weighed, were immersed in 300 ccs. of the solution, each in a separate beaker.

The stones remained thus for a period of fourteen days, with occasional turning over. At the end of this time they were carefully removed, and allowed to drain for some time into the beakers; then, after being rinsed for several hours in a current of water to thoroughly get rid of the acid, they were dried at 110 degrees C., cooled and weighed, and the loss in weight noted.

The solutions were then made up to 500 cc., one portion being used to determine the weight of the dissolved material as chlorides and sulphates, and the other for the chemical analysis of the dissolved material.

During the test some material fell away mechanically, due to the action going on between the matrix of the stone and the acid. This was caught in a filter, ignited, and weighed.

The effect of the acid on several of the stones was most pronounced, especially on those from Barrabool Hills, Apollo Bay, Darley. Sydney and Bacchus Marsh, while little or no change took place in the Stawell, Dunkeld, Egerton and Greendale stones.

The Barrabool Hills stone was bleached to a much lighter colour, and on fracturing the cube the alteration was visible up to about 1.5 cm. below the surface, gradually becoming lighter in colour outwards.

The Apollo Bay stone underwent a very decided change in colour, passing from a bluish-grey in the unaltered part to a tint resembling very closely that of cement on the outside. On fracturing the cube the zone of alteration was seen to be about 1.5 cm. wide, passing from the grey to a rather brown colour, due to the oxidation of the ferrous iron in the stone. From this point outwards there was a gradual loss of colour due to the solution of the iron-containing constituents, up to the cement colour about 1 mm. wide at the surface.

The Sydney stone, on the other hand, gained colour, due no doubt to the oxidation of the ferrous iron it contains, but the colouring was variable. On fracturing the cube it was seen that almost the whole of the stone had undergone an alteration in colour, there remaining a central core about 1 cm. in diameter of unaltered appearance. From this core outwards a beautiful zoning effect was produced, the colour being a deep brown, about 1.5 cm. from the surface, and then fading away to the surface, which in some cases was white and in others varying shades of brown.

The Darley stone was the most seriously affected of all, cracks extending along the bedding planes throughout the whole length of the cube. The cracks were more pronounced at the corners, where some of the material fell away—in fact, the stone required very careful handling to maintain the cubical shape at all. Thin flakes fell away, and a good deal of discolouration was produced by differential iron-staining.

The Bacchus Marsh stone underwent the same changes as the Darley stone, but they were not so pronounced, and little or no cracking was produced in it.

In the table are shown in percentages the total loss the stones underwent, the loss due to mechanical falling away, the loss due to the chemical action of the acids, and the soluble material as oxides, sulphates and chlorides.

During the experiment the CO_2 liberated by the action of the acid on any carbonates present escaped of course.

TABLE OF PERCENTAGE LOSSES IN ACID TEST.

Stone	Total Loss	Mechanical Loss	Loss by chem. action of acids	Sol. material as oxides, sulph'ts and chlorides
Stawell	0.108	0.019	0.089	0.050
Dunkeld	0.283	0.056	0.127	0.094
Barrabool Hills	1.417	0.027	1.390	2.889
Apollo Bay	1.851	0.020	1.831	2.813
Bacchus Marsh	0.792	0.025	0.667	1.225
Darley	1.835			2.337
Egerton (fine)	0.019*	0.015		0.068
Egerton (coarse)	0.027	0.067		0.080
Greendale	0.052*	0.034		0.221
Sydney	1.031	0.038	0.993	1.146

* Denotes gain in Weight.

The percentages of alumina, ferric oxide, magnesia and lime in the dissolved oxides were then calculated from the analyses of the dissolved material, and are as follows:

TABLE OF ANALYSES OF MATERIAL LOST BY CHEMICAL ACTION OF ACIDS.

	Stawell	Dunkeld	Barrabool Hills	Apollo Bay	Bacchus Marsh	Darley	Egerton (fine)	Greendale	Sydney
Alumina (Al_2O_3) -	36.25	16.50	66.25	59.85	24.25	16.00	27.22	31.53	5.20
Ferric Oxide (Fe_2O_3) -	28.13	34.38	31.14	26.65	3.00	25.85	37.10	22.91	83.92
Lime (CaO) - -	24.80	12.80	2.45	7.25	26.67	22.05	20.18	44.67	2.78
Magnesia (MgO) -	10.82	36.32	0.16	6.25	46.08	36.10	15.50	0.89	8.10

An examination of these tables shows that all the stones are more or less attacked by mineral acids, but that in the case of the fine-grained Egerton and Greendale stones there is a slight increase in weight, due probably to the formation of some new salt in the stone. The effect on the Stawell, Dunkeld, Egerton (both fine and coarse) and Greendale stones is very small, the Bacchus Marsh and Sydney stones are acted on considerably, and the Apollo Bay, Barrabool Hills, and Darley stones are affected to the greatest extent.

The mechanical loss is small in all the stones, with the exception of the Darley, but unfortunately a mishap took place with the insoluble portion of this stone, and time did not allow of a repetition of the experiment.

A perusal of the analysis of the dissolved material shows that in the Barrabool Hills and Apollo Bay stones a large percentage is alumina and ferric oxide, the ferrous iron dissolved from these stones being determined in the ferric state. The Barrabool Hills material contains more alumina and ferric oxide, and less lime and magnesia than the Apollo Bay stone.

In the case of the Sydney stone, more than 80 per cent. of the dissolved material is ferric iron, obtained from the solution

of ferrous carbonate in the stone, the other three oxides making up the balance with magnesia about 8 per cent. In the case of the Dunkeld and Stawell stones, which are of a different type from the others, the composition of dissolved material is more varied, there being a high percentage of magnesia for the Dunkeld stone and of lime for the Stawell stone.

For the Bacchus Marsh stone the ferric oxide is low, while the magnesia and lime are high, especially the magnesia, these two oxides being present in carbonates in the stone.

The Darley material is high in lime and magnesia, and low in alumina. The material dissolved from the Egerton and Greendale stones is much the same in composition, with the exception that the Greendale analysis shows a high lime and very low magnesia percentage, whereas in the Egerton material these two oxides are well distributed.

6.—*Microscopical Examination.*

Stawell Stone.

Examined under the microscope in thin section, this stone is seen to be made up almost entirely of rounded quartz grains, which are very closely packed together, so that there is a minimum amount of cementing material. A great number of the quartz grains contain numerous needles of rutile, while most of them have apatite, zircon, or small liquid inclusions, so that the sand grains are very probably of granitic origin. These quartz grains are of uniform size, and in nearly every case well rounded, showing that they have undergone a good deal of attrition before being cemented together. There are a few subangular, but almost no angular grains. A very occasional crystal of a light brown pleochroic mineral with a high refractive index is seen, and is probably the mineral sphene. The binding material is in parts seen to be secondary silica, while in other parts it is felspathic. Only occasionally do there occur patches of cement of any size, but the cementing together of a number of small quartz grains by secondary silica is very common. In the hand specimen numerous patches and bands of what are termed "flints" occur. On sectioning these

it is seen that they are nothing more than a number of grains cemented by secondary silica and are of secondary origin in the stone.

The average size of the grains is about .25 mm., and from a microscopical examination the sandstone appears to be almost the ideal one for weathering. (See Plate I., Fig. 1.)

Dunkeld Stone.

This is made up almost entirely of sand grains, but differs from the Stawell stone in that the grains are much smaller, and of a more angular character, also they are not so much compacted, with the result that there is a great deal more binding material.

This cementing material is uniformly stained with iron oxide, which gives it a light brown colour. It is the presence of a fair amount of this fine-grained matrix and the almost total absence of patches of secondary silica that renders this stone cheaper than the Stawell stone to work. (See Plate I., Fig. 2.)

Barrabool Hills Stone.

It is at once seen that this stone is of an entirely different nature from the Stawell and Dunkeld stones, and appears to be made up of reassorted igneous materials, most of which have been altered. Angular crystals of quartz are scattered through the rock, while a good deal of both orthoclase and plagioclase is present. Most of the felspars are kaolinised, and form part of the cementing matrix of the stone. The quartz and felspar fragments are set in a fine-grained matrix made up of chlorite, haematite, mica and volcanic fragments. The minerals in the rock are considerably altered, and this no doubt accounts for its low crushing strength. (See Plate II., Fig. 1.)

Apollo Bay Stone.

The description of the Barrabool Hills stone may be taken as that of this stone, with the exception that this is much fresher, and small grains of magnetite occur here and there through it. An examination of sections made from the freshly quarried stone, and of some which had been exposed for about

fifteen years, showed that there was little or no difference, so that the stone appears to have good weathering properties. (See Plate II., Fig. 2.)

Bacchus Marsh Stone.

It was a matter of some difficulty to obtain a thin section of this stone for microscopical examination, owing to its weak binding properties. The stone is made up of fine grains of angular quartz set in a fine-grained matrix of argillaceous material stained brown by ferric oxide. Occasional crystals of mica and felspar occur through the section, but the stone is almost entirely made up of sand grains, and a fine-grained matrix. The proportion of grains to matrix is far too small to allow of a good weathering stone, as the cementing matrix is of an argillaceous character, and so a poor binding material; thus from microscopical evidence one would conclude the stone to have a low crushing strength, and to have very little weather-resisting properties. (See Plate III., Fig. 1.)

Darley Stone.

This stone resembles closely that from Bacchus Marsh, but contains more fine-grained matrix, and in addition carbonates are present. The grains of quartz are small and angular, and well separated from one another. From the amount and argillaceous nature of the matrix, together with the presence of carbonates, one would consider the stone to have poor weathering properties, and to have a low crushing strength. (See Plate III., Fig. 2.)

Egerton Stone.

Fine-grained.—This is made up of very fine grains of quartz, set in a matrix of argillaceous material. The quartz grains are subangular, and of fairly even size. There is a fair percentage of fine-grained matrix, which is evenly distributed, and does not occur in large isolated patches. This stone is much superior to the Bacchus Marsh and Darley stones, from a microscopical point of view, and indicates good weathering properties, along with a fairly high crushing strength. (See Plate IV., Fig. 1.)

Coarse-grained.—This stone is of the same nature as the fine-grained one, but has a much coarser grain, and a good deal more argillaceous material all through it. The grains are angular, very uneven in size, .7 mm. to .07 mm. in diameter, and large isolated patches of the fine-grained matrix occur. This matrix is present to the extent of about 25 per cent., and patches 1 mm. in diameter occur. The microscopic characters indicate only fair weathering properties, and a low crushing strength.

Greendale Stone.

This has much the same microscopic character as the coarse-grained Egerton stone, but in addition has scattered through it specks of ferric oxide, which give the stone a light brown colour. (See Plate IV., Fig. 2.)

CHEMICAL ANALYSIS.

Chemical analyses were carried out by the author on all the sandstones, with the exception of the Stawell stone. The analysis of that stone in the following list was made by the Victorian Mines Department.[1]

In all cases samples for analysis were taken from material uniform with that used for the other tests. For stones of aqueous origin like these sandstones a chemical analysis does not carry so much weight as for igneous rocks, because in the former uniformity in either chemical or physical characters of even closely adjacent beds is not to be relied upon, whereas in igneous rocks which have cooled from a molten magma, uniformity of composition is much more likely. However, chemical analyses of these stones, while only holding for the particular beds of which they are samples, serve to indicate in general the composition of the stones, and what constituents are liable to alteration during weathering; this information used in conjunction with the other tests is often of great value.

The Stawell Stone is seen to be a very highly siliceous one, and to be made up almost entirely of silica in the form of sand grains. The combined water, alumina, and a certain amount of

[1] Ann. Report Sec. for Mines, Victoria, 1907, p. 63.

the silica occur in the small amount of cementing material in the stone. The iron oxides, magnesia, lime and alkalies are present to only a slight extent, while carbonates are altogether absent.

The Dunkeld is a little lower in silica than the Stawell stone, but it contains more combined water and alumina, owing to its larger percentage of cementing material, the alkalies are a little higher, but not present to any appreciable extent, while the iron oxides and alkaline earths are very low.

In neither of these stones does there appear to be any constituent easily affected chemically, under ordinary weathering conditions.

The Barrabool Hills and Apollo Bay Stones, from their chemical analyses alone, are seen to be different types of stones from the others, and a very close resemblance exists between the chemical constitution of these two, also a comparison of their analyses with those of the Victorian Dacites shows marked similarities. The silica is low, while the alumina, combined water, and alkalies are high.

The ferrous oxide in the Apollo Bay stone is about twice that of the Barrabool Hills stone, also the former has a lower ferric oxide value than the latter. It is the relative amount of these two iron oxides which governs the colour of the stone, the more ferrous oxide the greyer the stone, the brown colour of the Barrabool Hills stone being due to the ferric nature of the iron it contains.

A small portion of the fresh grey Barrabool Hills stone was analysed for ferrous iron, and gave 3.70 per cent., while an adjoining piece of brown stone gave only 1.80 per cent. The presence of the ferrous oxide in the stone must be regarded as a defect, as it is so readily oxidised on weathering.

The Bacchus Marsh Stone is only moderately high in silica for a sandstone, while the combined water and alumina are high, but this is a natural result of the large amount of argillaceous material the stone contains. The ferric iron value is high, and accounts for the brown colour of the stone, while the alkalies occur in the small amount of felspathic material the stone contains. Carbòn dioxide occurs to the extent of .32 per cent., and is combined partly with the lime and partly with the

magnesia. The presence of this material is detrimental, as it is readily removed under ordinary weathering conditions, thus weakening the stone.

The Darley has much the same composition as the Bacchus Marsh stone, but has less argillaceous material, and considerably more carbonates, the 1.82 per cent. of carbon dioxide is high, and occurring in a stone of weak physical features like this one is alone sufficient to condemn it for city structures. Manganous oxide occurs to the extent of .20 per cent., and in the form of manganese carbonate appears as the pink staining which the stone shows irregularly through it.

The Egerton and Greendale stones are similar to one another in composition, and are fairly high in silica. They contain a fair amount of argillaceous material, but there is nothing in either of the stones which is liable to chemical removal or alteration to any extent under normal weathering conditions.

TABLE OF CHEMICAL ANALYSES.

	Stawell	Dunkeld	Barrabool Hills	Apollo Bay	Bacchus Marsh	Darley	Egerton	Greendale
Silica (SiO_2) - -	96.19	90.49	64.13	64.00	77.69	83.15	90.22	86.37
Alumina (Al_2O_3) -	1.90	5.66	18.59	15.88	10.00	5.48	7.56	7.29
Ferric Oxide (Fe_2O_3)	0.37	0.59	1.99	1.90	2.70	1.57	tr.	1.67
Ferrous Oxide (FeO) -	0.06	nil	1.78	3.86	tr.	nil	nil	nil
Magnesia (MgO) -	0.09	tr.	1.24	1.81	0.96	0.64	tr.	0.43
Lime (CaO) - -	tr.	0.27	1.34	2.02	0.74	2.90	tr.	tr.
Soda (Na_2O) - -	0.04	0.88	4.36	3.42	1.02	0.56	0.38	0.84
Potash (K_2O) - -	0.39	0.46	1.98	1.86	1.74	0.24	0.22	0.34
Free Water ($-H_2O$) -	0.11	0.20	1.38	1.04	1.56	0.46	0.58	0.10
Combn'd. „ ($+H_2O$) -	0.48	0.97	3.43	3.84	3.02	2.51	1.56	2.50
Carbon Dioxide (CO_2)	nil	nil	sl. tr.	nil	0.32	1.82	nil	nil
Mang. Oxide (MnO) -	—	nil	str. tr.	str. tr.	tr.	0.20	tr.	tr.
Titanium Oxide (TiO_2)	0.10	—	—	—	—	—	—	—
Total -	99.73	99.52	100.22	99.63	99.75	99.53	100.52	99.54

GENERAL SUMMARY OF RESULTS.

Stawell Stone.—This has excellent weathering properties, as shown by its low absorption, great resistance to corrosion by carbon dioxide, and to the action of mineral acids. It has a very high crushing strength, and is an expensive stone to dress. Chemically the stone is very stable, and microscopically appears almost the ideal weathering sandstone. The objections which may be raised to the stone are its cost of dressing due to the initial hardness and the "flints," the presence of current bedding, and its cold appearance. On the other hand, it is the best weathering sandstone in Victoria, and blocks of any reasonable size may be obtained, so that for public buildings it is an eminently suitable one.

Dunkeld Stone.—This has excellent weather resisting properties, on account of its low absorption, its resistance to carbon dioxide and the mineral acids. Its crushing strength is only fair, but it is considerably cheaper than Stawell stone to dress. A grave objection to this stone is its appearance on weathering, due to the very frequent current bedding, to the differential iron-staining, and to the pitting along the bedding planes, owing to the falling out of fine powdery material originally present. It must be regarded as only a second-class stone.

Barrabool Hills Stone.—This has a very high absorption, and, while resistant to the effect of carbon dioxide, is readily affected to a large extent by mineral acids. It is light, has a low-crushing strength, and is easily dressed. An examination of the buildings of this stone, together with the results of the above tests, indicates that the stone is only a fair one, and that when used in rough dressed blocks of small size gives the best results.

Apollo Bay Stone.—This is fairly compact, has a medium absorption, is very resistant to carbon dioxide, but readily acted on by mineral acids. It has a good crushing strength, and works both freely and well. Objections may be urged against the colour, especially after weathering for some time, and to the action of acids on it; but in virtue of its absorption, its dressing properties, and its known weathering properties it must

be set down as a much better stone than that from the Barrabool Hills and as a good stone.

Bacchus Marsh Stone.—This is not at all a durable stone, on account of its physical and chemical characters. It is light, and has a low crushing strength due to the poor adherence of its particles. Owing to its chemical constitution it is attacked and weakened by the action of carbon dioxide, and especially by the mineral acids. It has a very high absorption, and from the durability of the stone, as seen in Bacchus Marsh and Melbourne, cannot be regarded as other than a poor stone.

Darley Stone.—This is poor, both physically and chemically, as a building stone. It is light, very porous and has an exceedingly low crushing strength. It yields to the attack of carbon dioxide and the mineral acids very readily, owing largely to the carbonates it contains. It is interesting to note that at one time this stone was chosen for the Houses of Parliament, but from the results obtained above, and an examination of the stone in Melbourne structures, it must be considered a very poor stone for building purposes, especially in the city.

Egerton Stone (Fine-grained.)—This has a fair crushing strength, is rather absorptive, but very resistant to carbon dioxide, and the mineral acids. It has the advantage of being light, dressing easily and well, and from what is known of its weathering properties in the field should be a good, durable stone if precautions are adopted to keep it as dry as possible. The stone has not been used to any extent, but if the quarry opens up favourably, as it promises to do, it should fill the long-felt want of a durable stone with cheap dressing qualities.

Coarse-grained.—This is physically weaker than the fine-grained material, but is chemically stable. It dresses easily, and although inferior to the former one, should, with the same precautions, prove a good serviceable stone.

Greendale Stone.—This has much the same qualities as the coarse-grained Egerton material. It is light, has a low crushing strength, is rather absorptive, but very resistant to the action of carbon dioxide and the mineral acids. No opportunity of judging this stone in the field has been obtained, but from the laboratory results it should, if kept reasonably dry, prove a good serviceable stone.

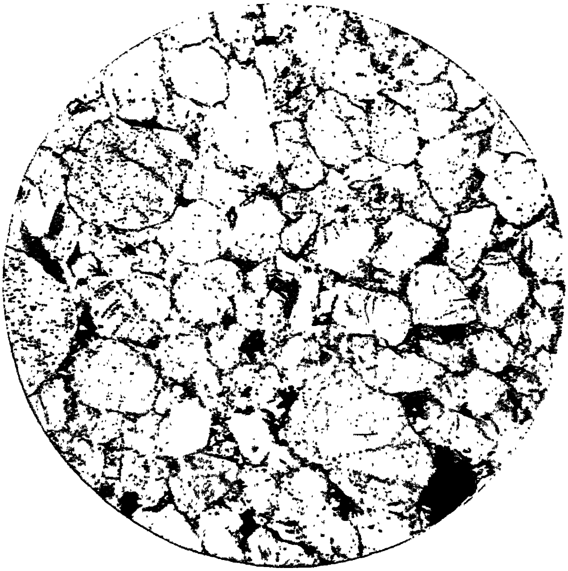
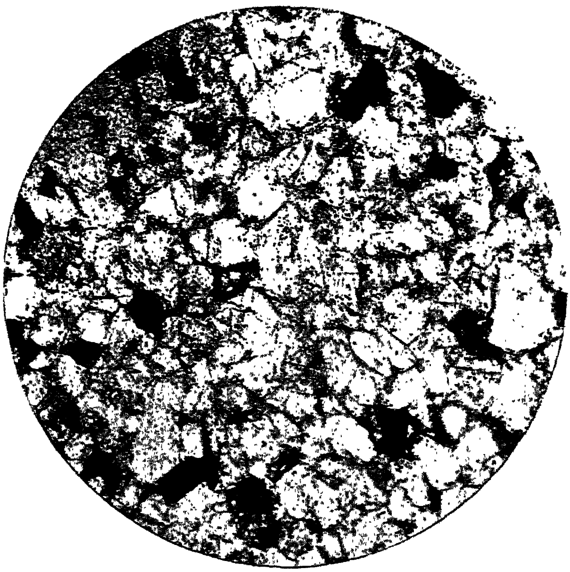


Fig. 1



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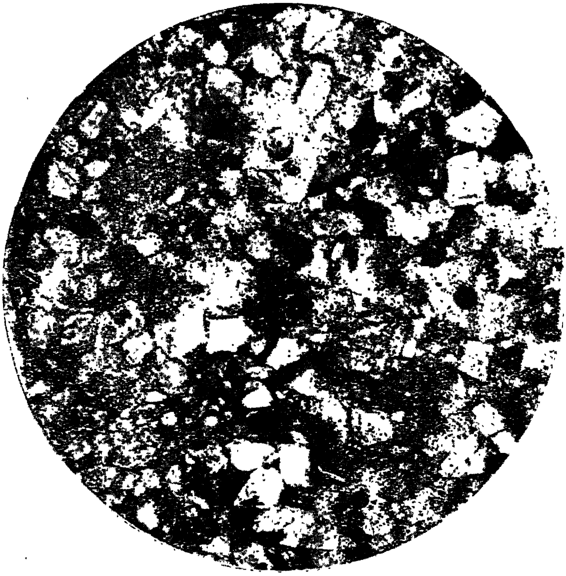
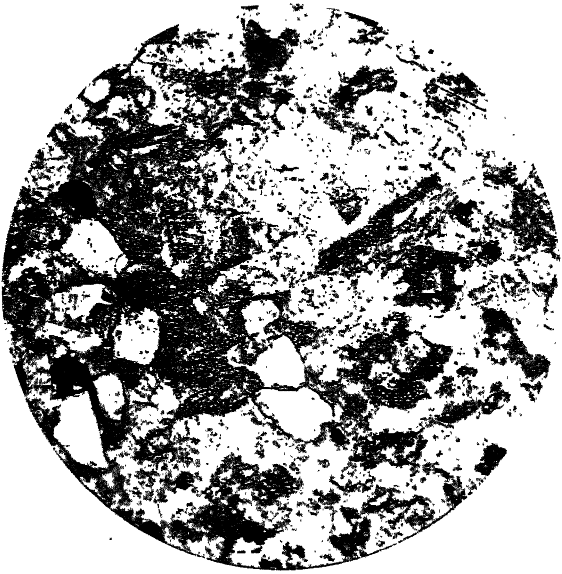


Fig. 1



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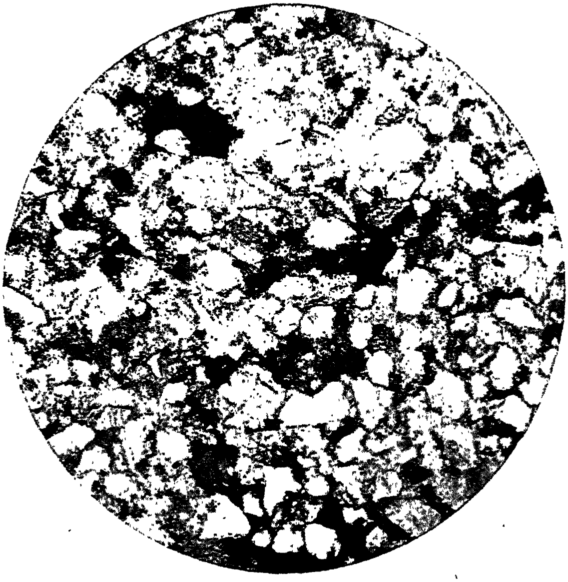

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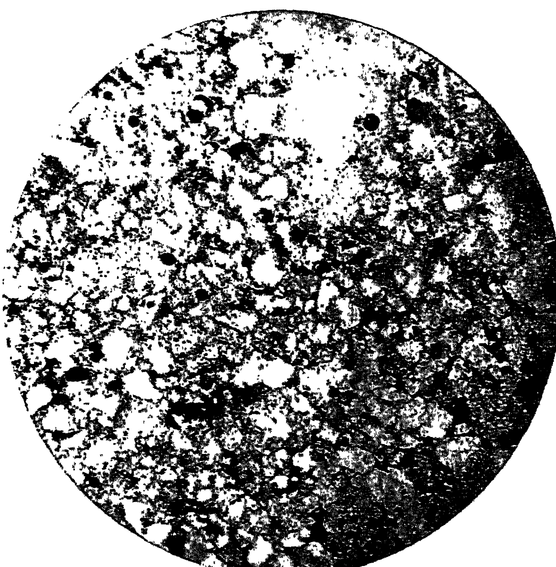

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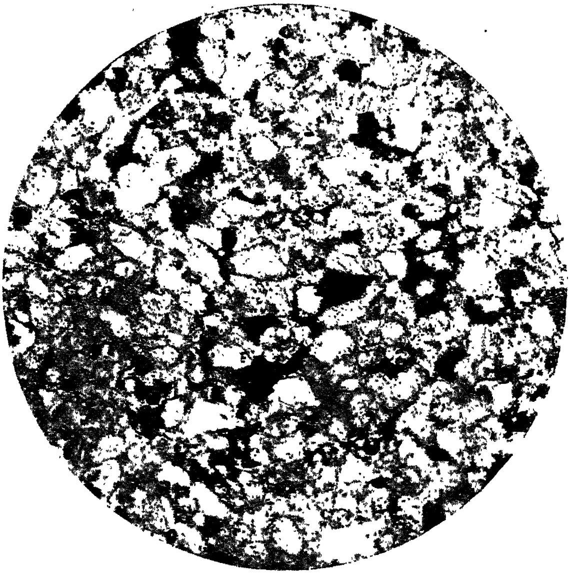

Fig. 1

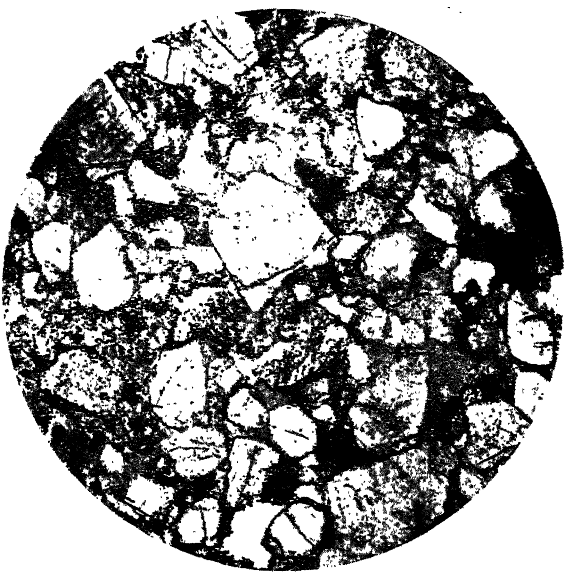

Fig. 2

In conclusion, I am much indebted to Prof. E. W. Skeats for his kindly advice on many occasions, and to Mr. H. J. Grayson for his help in preparing the microscopic sections and microphotographs.

DESCRIPTION OF PLATES XXXIII.-XXXVI.

The microphotographs are all × 35 diameters and taken in ordinary light.

Plate XXXIII.

Fig. 1—Microphotograph of Stawell Sandstone.
„ 2— „ „ Dunkeld Sandstone.

Plate XXXIV.

Fig. 1—Microphotograph of Barrabool Hills Sandstone.
„ 2— „ „ Apollo Bay Sandstone.

Plate XXXV.

Fig. 1—Microphotograph of Bacchus Marsh Sandstone.
„ 2— „ „ Darley Sandstone.

Plate XXXVI.

Fig. 1—Microphotograph of Egerton Sandstone (fine).
„ 2— „ „ Greendale Sandstone.

[Proc. Roy. Soc. Victoria, 22 (N.S.), Pt. II., 1909.]

Art. XIV.—*The Structure of the Truncus Arteriosus in Species of the genera Hyla, Limnodynastes, Chiroleptes, Heleioporus, Pseudophryne and Notaden.*

By KATHLEEN K. OLIVER.

(With Plates XXXVII -XXXIX).

[Read 9th December, 1909.]

In reading various bioligical authorities I have noticed a marked discrepancy in the different accounts of the number and relative importance of the valves of the frog's heart.

A. Milner Marshall and Ecker both deal with *Rana temporaria*, and each gives a different number of valves as guarding both the entrance to the Truncus Arteriosus from the Ventricle, and to the Synangium, from the Pylangium.

Bourne, in his description of the frog, does not name the species on which he is working, merely giving the generic name of *Rana*, and differs again in regard to the number of valves from both of the two above authorities.

In the following account a description is given of the structure of the Truncus Arteriosus in representatives of the three families of the Amphibia that are found in Australia. The species examined are as follows:—

Family *Hylidae*.

Hyla aurea.

Family *Cystignathidae*.

Limnodynastes dorsalis.

Heleioporus pictus.

Chiroleptes alboguttatus.

Family *Bufonidae*.

Notaden bennetti.

Pseudophryne semimarmorata.

My thanks are due to Professor Spencer for his kind help, and for the use of the laboratory and department specimens of

the Melbourne University, also to Mr. John Booth and Mr. J. C. Gilmour, for the live specimens they have been at trouble to procure for me, thus aiding me in investigation with the dissecting microscope.

As regards the nomenclature of the valves to be dealt with hereafter, as no definite names appear to have been hitherto applied to them, I have called those between the Ventricle and the Pylangium the *pylangial valves*, and those between the Pylangium and Synangium, the *synangial*.

The accompanying table will serve to show the discrepancies in the accounts of the valves of the truncus arteriosus given by certain authors.

The interior of the truncus, as is well known, is divided into two parts—the proximal, called the *Pylangium*, and the distal, the *Synangium*.[1] In some species the line of demarcation between these two portions of the Truncus Arteriosus is very distinct externally (Fig. 2), while in others — e.g., *Hyla aurea* (Fig. 1)—there is little or no outward evidence of the division into proximal and distal compartments.

Just to the left of the opening from the ventricle, a dorsally attached septa arises, running the whole length of the Pylangium, and called, from the spiral twist in it, the *spiral valve or fold.* This spiral valve is free ventrally, and normally turns from the right side at the posterior end, to the left at the anterior. At the anterior end of the valve there are more or less well marked valves guarding the entrance to the Pulmo-cutaneous arch.

The Synangium is that part of the truncus which is anterior to the spiral valve, and from it arise the systemic and carotid arches. The spiral fold is a constant feature, differing only as to shape and relative thickness in the various genera. The valves at the anterior end of the spiral fold, separating the Pylangium from the Synangium, while constantly present, are

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1 Different authors apply different names to the parts associated with what we call the *Truncus arteriosus*. Marshall, whom we follow, calls the whole structure the *Truncus arteriosus*, and divides it into a proximal part, the *Pylangium*, and a distal, the *Synangium*. Howes confines the term *Truncus* to the proximal part; Parker and Haswell call the proximal part the *Conus arteriosus* and the distal *bulbus aortae;* Holmes calls the proximal part the *bulbus cordis*, and the distal the *Truncus arteriosus*, whilst Ecker calls the proximal part the *Truncus*, though he sometimes applies the same name to the combined proximal and distal parts.

Author	No. of Pylangial Valves	No. of Synangial Valves	Position of opening of Pulmo-cutaneous Arch
Marshall, "The Frog," 8th ed., 1902. Rana —	3 semilunar	3 semilunar	Synangium
Howe's Atlas of Pract. Vert. Zootomy, 1902, pl. 11. R. esculanta	Number not stated	Number not stated	Pylangium
Sedgwick, "Text-book of Zoology," p. 282. Rana platyrrhina	3 semilunar	3 semilunar	Pylangium
Bourne, "Comp. Anatomy of Animals. Rana —	2 semilunar	3, to one of which spiral fold is fused	Opens "just above the middle and smallest of the three valves'
Holmes, "Biology of the Frog," p. 266; diagrams from Parker and Haswell, and Howes	3	Spiral valve "widens out at its anterior end into a cup-like valve. Two smaller valves occur at the same level"	Copies drawings in Parker and Haswell
Thomson, "Outlines of Zoology," p. 571	"Opening of pylangium into ventricle is guarded by 2 semilunar valves"	Number not stated	Not stated
Parker and Haswell, "Text-book of Biology," p. 259. R. temporaria	3 small semilunar	1 valve, "and by the free end of the longitudinal valve"	"Conus" (= pylangium)
Parker and Parker, "Pract. Zoology," p. 87. R. temporaria	3 semilunar	1 semilunar, and "free flap of longitudinal valve. The pulmo-cutaneous aperture is also guarded by a small valve."	"Conus"
Chalmers Mitchell, "Outlines of Biology," p. 251	3 semilunar	"3 pocket-shaped valves, the openings of which are directed away from the heart."	Aperture of pulmo-cutaneous trunk "immediately behind" the valves
Rolleston, "Forms of Animal Life," ed. by Jackson, p. 76	3 semilunar	3, of which one is the spiral fold. Two other smaller ones, one dorsal, one ventral. A vertical septum placed transversely divides origin of pulmonary arteries from the origin of aortae and carotids.	Pylangium
Eckes, "The Frog," 1st ed., English trans.	2	1	Pylangium

more or less modified in the different genera. In some cases one or other of them seem almost to disappear; in others they appear to be fully developed, and show distinct fusion with the top of the spiral fold.

There is in *Hyla aurea* a modification of the spiral fold, which will be recorded under the detailed account of that genus, and which is interesting physiologically, in that it suggests a theory of the blood flow which as yet does not appear to have been considered. The solid objects are drawn as dissected, and the sections are taken from consecutive series, the most diagrammatic and typical being chosen.

HYLIDAE.

1. *Hyla aurea.* (Plate XXXVII., Figs. 1, 2, 3, 4, 5, 6.)

The opening from the Ventricle to the Truncus Arteriosus is on the right of the spiral fold, at the extreme proximal end. It is guarded by two laterally placed semi-lunar valves, connected by cordae tendinae, with the inner wall of the Pylangium.

At the anterior end of the spiral fold, guarding the opening to the Pulmo-cutaneous arch, and on the left side of the fold, is one very definite semilunar valve (v.), attached dorsally, and free ventrally, and one small flap of membrane which may be taken as a half valve. It lies to the right of the larger valve, and is fused with it, and lies dorsal to the turned top of the spiral valve, so as to be invisible in a dissection from the ventral side. The spiral valve in Hyla is very strongly developed, there being a very definite spiral twist. (Fig. 1.) The free edges are thicker than the main part of the valve, and are softly rounded. It is attached dorsally only, and is free along the whole ventral border. The right hand end of the synangial half-valve fuses with the spiral valve a short distance posterior to the anterior end of its free edge.

The papilla on which the Carotids open (Car.) is most distinct, its edges overlapping the opening to the systemic to a slight extent.

Developed in connection with the spiral valve is an interlocking apparatus, presumably junctioning in conjunction with

the synangial valves in regulating the blood flow through the Truncus.

On the right hand wall of the Truncus a definite, papilla-like structure is present (p), and opposite it on the same side of the fold is a depression (d), into which the papilla fits. Bourne, in his work on Rana, states that the Pulmo-cutaneous arch opens from the Synangium, anterior to the spiral valve and its attendant synangial valves; also he figures the valves as facing up towards the cavity of the Synangium.

The synangial valves in the Australian frogs that I have investigated are between the Pulmo-cutaneous arch and the Synangium, and this position, together with the presence of the interlocking apparatus, would suggest the following theory as to the regulation of the blood flow through the Truncus—that when the spiral valve is in its normal position—that is, the position in which there is least pressure exerted on it—and this is when the pressure is greatest in the Synangium, and therefore lower in the Pylangium, the interlocking apparatus is closed, the papilla on the Pylangial wall fitting closely into the depression on the spiral valve. In this position the spiral valve would direct the impure blood, entering first on the Ventricular Systole to the left, and so on up to the Pulmo-cutaneous arch, where the pressure is lowest, the preceding systole having forced the blood on to the lungs. When the Pylangium is full, and the pressure becomes greater than that above in the Synangium, the blood forces up the Synangial valves, and these, being fused with the spiral valve, pull the fold over to the left, thereby opening the interlocking apparatus, and the blood rushes towards the Systemic and Carotid area, there being now less pressure than in the Pulmo-cutaneous entrance.

CYSTIGNATHIDAE.

1. *Limnodynastes dorsalis.* (Plate XXXVIII., Figs. 9-10.)

In *Limnodynastes dorsalis* there are two very distinct synangial valves (Fig. 9 v^1v^2). The valve attached to the left side of the Truncus is large, semi-lunar, and definite, and that further to the right is smaller, its right hand end fusing with the anterior end of the spiral valve. Both valves have their cups

directed inwards towards the cavity of the Pylangium guarding the entrance to the pulmo-cutaneous arch, as is the case in all other genera I have worked in the Australian frogs.

The Pylangial valves (Fig. 10 v^1v^2) are characterised by the presence of two distinct papilla-like structures (Fig. 10 p.p^1), one at the dorsal, and one at the ventral junction of their lips.

The interlocking apparatus is represented in this genus by a somewhat thicker attachment of the spiral valve to the dorsal wall, the ventral surface of which is slightly rounded, so as to fit into the curve of the spiral valve on the right side when that structure swings over from the left.

The fold itself is much less definitely spiral than that of other genera. The edges are very blunt, and the main part much thicker than in the case in Hyla. The carotid papilla also is less well defined than in the other Australian genera worked.

2. *Heleioporus pictus.* (Plate XXXVIII., Fig. 12.)

In *Helioporus pictus* the edges of the spiral valve are sharply marked and definite, and there is a decided right to left spiral twist. The Pylangial valves are two in number, with a small papilla on the dorsal wall of the opening, and a less well-defined and smaller one on the ventral.

Two synangial (Fig. 12 v^1) valves are present, each of a very indistinct transparent and membraneous appearance, and each of approximately the same size. The right one is attached at the right side to the anterior end of the spiral valve, at its ventral margin, and the other end is fused with the left hand valve just above the opening to the Pulmo-cutaneous arch.

The interlocking apparatus is most indefinite in this genus, being represented by a slight indentation on the fold and a very slight thickening of the wall opposite it, much as in *Lymnodynastes dorsalis.*

3. *Chiroleptes alboguttatus.* (Plate XXXIX., Fig. 14.)

In this genus the carotid papilla (car.) is very marked. The spiral valve is not at all well developed, there being very little spiral twist present.

The interlocking apparatus is faintly marked, the papilla-like structure on the wall of the Truncus being the only indication of it. There is one very definite synangial valve on the left lateral, and ventral side (Fig. 14 v.[1]), and a narrow flap of skin fused to the top of the spiral fold on the right and attached across the dorsal side of the Truncus just above the opening of the Pulmo-cutaneous arch. (Fig. 14 v.[2]) The semilunar valves are placed laterally, without any dorsal and ventral papillae. Taken altogether, this genus appears to be further from the usual structure of the Truncus than any of the so far worked families or genera.

Bufonidae.

1. *Notaden bennetti.* (Plate XXXIX., Fig. 15.)

The spiral fold is here most definitely curved, and has a thick, coarse edge.

The interlocking apparatus is represented by a very faint papilla on the wall of the Truncus, opposite the top curve of the spiral fold, into which it presumably fits, instead of having a separate indentation as in other genera.

The synangial valves (Fig. 15 v^1v^2) are two in number, both approximately of the same size. The right end of the right valve being, as usual, fused to the spiral fold, and attached at its left end to the spot from which the left valve springs. The spot at which the right and left valves join each other is immediately above the opening of the Pulmo-cutaneous arch.

The Carotid papilla is very marked, and relatively large. The semilunar pylangial valves (Fig. 16 v^1v^2) are closely opposed when shut, there being no papillae on the dorsal and ventral sides.

In a longitudinal horizontal section (Fig. 17), the very distinctly spiral form of the spiral fold will be clearly seen.

2. *Pseudophryne semimarmorata.*

This genus is too small for dissection, so the structure can only be arrived at by means of sections.

There are apparently two synangial valves (Fig. 18 v^1v^2), much the same as in other genera, and the spiral valve seems

to be less curved than is usually met with in the other Australian frogs so far investigated.

The carotid papilla is present, but does not appear to be exceptionally large.

SUMMARY OF RESULTS.

The Truncus Arteriosus is divided into two distinct portions —the proximal Pylangium, between which and the Ventricle are the Pylangial valves, and the distal portion or Synangium, separated from the Pylangium also by valves. It is chiefly with these valves and associated structures that this paper deals. Various authors (see Table) have worked out these valves in Rana, and the result has been such that a marked discrepancy is apparent. Also there appears to be some doubt as to the relative position of the Synangial valves and the Pulmo-cutaneous opening. Some authorities depict the Pulmo-cutaneous opening in the Synangium, and the cups of the valves facing anteriorly; some place it in the Pylangium, with the cups of the valves facing posteriorly. As these two positions would necessarily give totally different methods of the blood flow through the Truncus, it is of importance to ascertain the positive position of these parts.

In the Australian frogs worked there is a constant number of Pylangial valves (2), and also of Synangial valves (2), the structure and development in the different genera only being subject to variation. In every individual investigated, the Pulmo-cutaneous arch has opened from the Pylangium, and has been guarded by the Synangial valves which face posteriorly, towards the cavity of the Pylangium. This position of the Pulmo-cutaneous arch in relation to the Syangial valves, together with the interlocking structure, suggests the above-mentioned theory of the blood flow through the truncus.

In the following table the number and importance of Pylangial and Synangial valves is indicated, together with the position of the Pulmo-cutaneous aperture in the specimens examined.

Family	Genus and sp.	Pylangial Valves	Synangial Valves	Aperture of P.C.
Hylidae	Hyla aurea	2	1 + small ½ valve	Pylangium
Cystignathidae	Limnodynastes dorsalis	2, with distinct papillae	2	Pylangium
	Heleioporus pictus	2, with small papillae	2	Pylangium
	Chiroleptes alboguttatus	2	1 distinct and 1 poorly developed	Pylangium
Bufonidae	Notaden bennetti	2, with no papillae	2	Pylangium
	Pseudophryne semimarmorata		2	

LIST OF WORKS REFERRED TO.

A. Milner Marshall.—"The Frog," 8th ed., 1902.

Howes.—"Atlas of Practical Vertebrate Zootomy," ed. 1902, plate II.

Sedgwick.—"Student's Text Book of Zoology," p. 282.

Bourne.—"Comparative Anatomy of Animals."

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Thomson.—"Outline of Zoology," p. 571.

Parker and Haswell.—Vol. II. "Text Book of Biology," p. 259.

Parker and Parker.—"Practical Zoology," p. 87.

Chalmers Mitchell.—"Outlines of Biology," p. 251.

Rolleston.—"Forms of Animal Life," ed. by Jackson, p. 76.

Ecker.—"Anatomy of the Frog," ed. George Haslam, 1888.

EXPLANATION OF PLATES.

List of abbreviations used.

P = Pylangium.
S = Synangium.
Car = Carotid Papilla.

V^1 = first valve.
V^2 = second valve.
p = papilla on wall of Pylangium.
d = depression on spiral fold opposite p.
p^1 = papilla at Pylangial valves.

Plate XXXVII.

Fig. I.—Heart of *Hyla aurea*, showing no outward line of demarcation between the Pylangium and Synangium.

Fig. II.—Heart of *Limnodynastes dorsalis*, showing distinct outward line of demarcation between Pylangium and Synangium.

Fig. III.—Drawing of a dissection of the Truncus Arteriosus of *Hyla aurea*, seen from ventral surface.

Fig. IV.—The posterior end of the Truncus Arteriosus of *Hyla aurea*, showing the Pylangial valves.

Fig. V.—Truncus Arteriosus of *Hyla aurea*, showing the interlocking apparatus open.

Fig. VI.—Truncus Arteriosus of *Hyla aurea*, dissected from the ventral aspect, showing the interlocking apparatus shut.

Plate XXXVIII.

Fig. VII.—Longitudinal horizontal section of *Hyla aurea*, to show the Synangial valves.

Fig. VIII.—Longitudinal horizontal section of *Hyla aurea* heart, to show Pylangial valves.

Fig. IX.—Truncus Arteriosus of *Limnodynastes dorsalis*, to show Synangial valves.

Fig. X.—Truncus Arteriosus of *Limnodynastes dorsalis*, to show Pylangial valves.

Fig. XI.—Longitudinal Horizontal section of Truncus Arteriosus of *Limnodynastes dorsalis*, to show the Synangial valves.

Fig. XII.—Truncus Arteriosus of *Heleioporus pictus*, to show Synangial valves.

Plate XXXIX.

Fig. XIII.—Compiled longitudinal horizontal section of *Heleioporus pictus*, to show Synangial valves.

Fig. XIV.—Truncus Arteriosus of *Chiroleptes alboguttatus*, to show Synangial valves.

Fig. XV.—Truncus Arteriosus of *Notaden bennetti*, to show Synangial valves.

Fig. XVI.—Truncus Arteriosus of *Notaden bennetti*, to show Pylangial valves.

Fig. XVII.—Longitudinal horizontal section of Truncus Arteriosus of *Notaden bennetti*, to show Synangial valves.

Fig. XVIII.—Longitudinal horizontal section of Truncus Arteriosus of *Pseudophryne semimarmorata* to show Synangial valves.

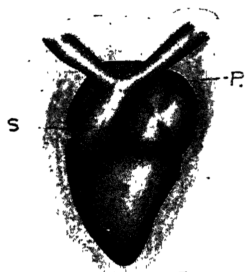

Fig. 1

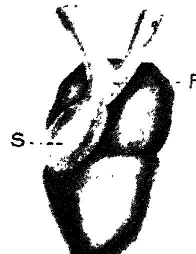

Fig. 2

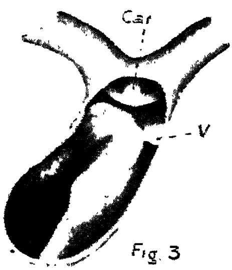

Fig. 3

Fig 4

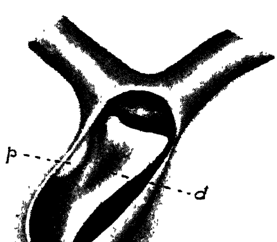

Fig. 5.

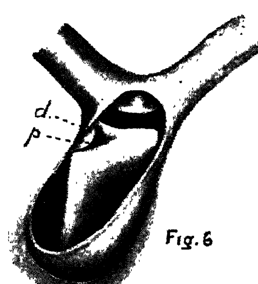

Fig. 6

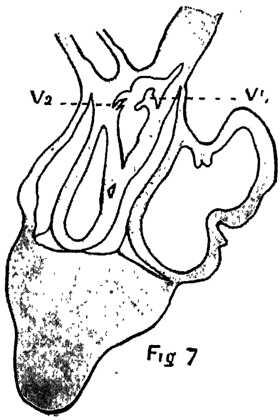

Fig 7

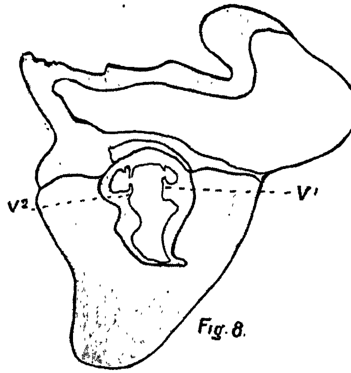

Fig. 8.

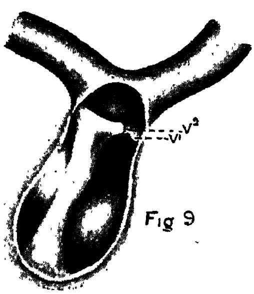

Fig 9

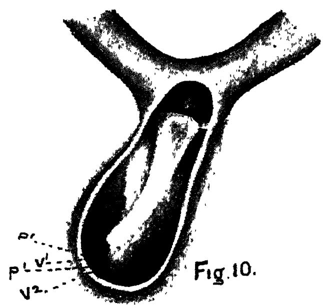

Fig. 10.

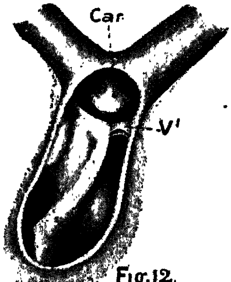

Fig. 12.

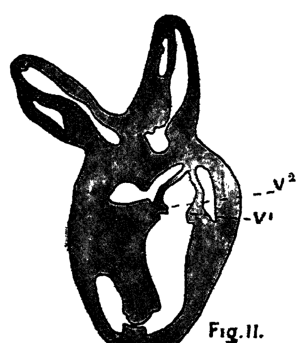

Fig. 11.

[PROC. ROY. SOC. VICTORIA, 22 (N.S.), PT. II., 1909.]

ART. XV.—*Contributions to our knowledge of Australian Earthworms.*

THE BLOOD VESSELS—PART II.

BY GWYNNETH BUCHANAN, B.Sc.

(With Plates XL.-XLII.).

[Read 9th December, 1909].

The present paper is a continuation of that previously published by me on the same subject (Proc. Roy. Soc. Vic., vol. xxii., pt. I., 1909), and has, like it, been undertaken in the Biological Laboratory of the Melbourne University, under the direction and advice of Professor Spencer. The bibliography is the same as before, and I have continued to employ the generic names given by Beddard in his "Monograph of the Order Oligochaeta" (from which also all the references in the text are taken) except in such cases as are indicated in which they have been altered in harmony with Michaelsen's later work.

The following is a list of the genera and species dealt with in the preceding paper:—

Cryptodrilus hulmei.
Digaster excavata.
Diporochaeta bakeri.
,, copelandi.
,, davallia.
,, richardi.
,, tanjilensis.
,, yarraensis.
Fletcherodrilus unicus.
Megascolex coxii.
,, dorsalis.
,, fielderi.
,, goonmurk.
,, tenax.[1]

[1] Michaelsen uses this genus instead of Megascolides, "Die Fauna, Südwest Australiens," 1907, Oligochaeta, p. 160.

Woodwardia gippslandicus.
Perichaeta obscura.
„ manni.
„ macquariensis.
„ valida.

While those described in the present one are:

Cryptodilus grandis.
„ manifestus.
„ saccarius.
Megascolex australis.
Notoscolex camdenensis.
„ queenslandica.

1.—**Megascolex australis**, Fletcher.

Perichaeta australis, Fletcher. Proc. Linn. Soc. N.S.W., vol. i., 1886.

Plate XL., Fig 1.

Dorsal vessel. single, swollen in segments 15-10, and passing forward to the first segment, when it sends an exceedingly fine branch round the alimentary canal, which unites with the ventral on each side. In 15 and 16 it gives off two well marked vessels to the alimentary canal in each segment, while in 14 there is only one, and in 13 none at all. In 12, 11 and 10, a pair of *hearts* arise in the hinder part of each segment, whose connections with the dorsal vessel are so small as to be only discernible in serial sections, the hearts arising from a very definite *supra-intestinal*, which takes its origin as a separate vessel over the alimentary canal in 13, and which runs forward to end blindly over the same organ in 9. From 9-6 distinct commissurals pass from the dorsal at the hinder end of each segment to the ventral vessel, sending a branch to the posterior septum and ventral body wall. From 5 forwards these vessels are very small, and hard to trace among the exceedingly strong muscles, but there is apparently one leaving the dorsal and entering the ventral in each segment. In 5, that from the dorsal breaks up into fine capillaries, about half way down the segment, which appear to connect with another set associated

with the anterior end of the *lateral vessel*, but their direct continuity is hard to make out. The lateral runs backwards, sending a branch to the posterior septa of the segments in 6-9, and passing below the alimentary canal as the sub-intestinal in 10-13, on the hinder septum, of which last segment it ends. It receives branches from the calciferous glands, apparently derived from the supra-intestinal in 10, 11 and 12, and others from the alimentary canal, whose origin is less obvious in 13 and 9, giving branches to the posterior system of the segment in 10, 11 and 12.

The ventral is a single vessel, not clearly marked in the anterior segments, giving branches to the ventral body wall in each posterior to 13, and joining the dorsal as described. The difficult point to explain is the slight connection between the hearts or supra-intestinal vessel with the dorsal, the only truly functional branches arising from this in the region of the hearts being those to the posterior septa of the segments, and these are so small as to be best made out from sections.

The explanation seems to be found on an examination of a series of sections passing from segment 9 to about segment 15 or 16. The dorsal vessel is greatly expanded in the segments immediately posterior to the hearts, its walls having the typical structure described by Beddard (p. 65), consisting of an epithelial wall surrounded by circular and longitudinal muscles. This vessel, evidently well fitted for pumping action, gives marked vessels to the alimentary canal as described, but from this organ the blood is passed to the ventral by very insignificant branches. It must therefore pass along the alimentary canal in the sinus-like vascular space surrounding it, to be collected to the definite supra-intestinal vessel in 13; and the pumping force of the dorsal vessel must be strong enough to pass it forward till it reaches the hearts, where fresh propulsion will take place, since the connections of these vessels with the dorsal are so small as to be negligible from a functional point of view. The supra-intestinal, though not a very large vessel, has, in the region of the calciferous glands, fairly muscular walls, which would be capable of propelling the blood, but this theory does not explain the more than usually muscular walls of the dorsal vessel in this region.

2.—**Notoscolex camdenensis**, Fletcher.[1] Proc. Linn. Soc. N.S.W., vol. i., 1887.

Cryptodrilus camdenensis, Fletcher.

Plate XL., Fig. 2.

Dorsal vessel single, swollen in segments 17-14, less so in 13-10. It passes forward to 1, where it apparently breaks up; but from 4-1 the muscles are very thick, and in these segments the connections between the dorsal and ventral, if present, are indistinct. In 17-14 the dorsal gives clear vessels to the calciferous glands, and posterior to these in each segment one or two branches to the alimentary canal, whose connections with the ventral are small, and barely to be made out even in sections. From 9-6 a pair of commissural vessels arises from the dorsal at the hinder end of each segment, showing some distance along their course a construction probably due to the presence of a valve. From this point (which is higher than in the other vessels) in 6, arises a *lateral* passing backwards, and closely applied to the alimentary canal. Below the valve the commissurals give branches to the posterior septa of the segments, there being many of these vessels in 6. The lateral is fairly distinct in 7, 8 and 9, closely applied to the alimentary canal, receiving vessels from it, and sending branches to the posterior septa; but in the region of the hearts it becomes indistinct, and only apparent as the *sub-intestinal* on each side in sections, where it is seen to end in the sinus around the alimentary canal in 13, sending small branches to the posterior septa in 10-13. *The hearts* are four pairs, in segments 10-13, arising mainly from the *supra-intestinal*, but each receiving a small branch from the dorsal. They are somewhat moniliform in appearance, and fine at their junction with the ventral, and in section are found to contain valves, which have also been noticed in the hearts of other worms. (See Beddard, p. 73.)

The supra-intestinal arises as a definite vessel from the sinus around the alimentary canal in 13, and passes forwards to end above that organ in or about segment 9. It is the main origin

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1 Michaelsen retains Fletcher's genus Notoscolex "Die Fauna, Südwest Australiens," 1907, Oligochaeta, p. 162.

of the hearts, as has been said, though it becomes rather indistinct between them, and is connected with the large sinus around the alimentary canal in this region, though not by very definite vessels, passing to the sub-intestinal.

The ventral is single, and passes forward to where it breaks up into fine branches, which may or may not join the dorsal. In 2 it sends branches to the alimentary canal, and behind the heart region a vessel to the posterior septum and ventral body wall in each segment. As has been said, the connection between the dorsal and ventral by way of the alimentary canal is indistinct. This, however, is common, as Beddard (p. 72) remarks that in earthworms the commissurals are confined to the anterior segments of the body, but in the embryo of Lumbricus each segment has a pair of commissurals. Evidently, therefore, it is better to call these vessels in the hinder regions of the body dorso-intestinal.

3.—Notoscolex queenslandica,[1] Spencer.

Cryptodrilus queenslandica, Spencer. Proc. Roy. Soc. Vict., vol. xiii., pt. i., 1900.

Plate XL., Fig. 3.

Dissection.—Dorsal vessel single, swollen in segments 18-10, and giving off distinct dorso-tegumentary vessels to the hinder mesenteries in those posterior to the hearts. The tegumentary blood system is very well marked along the whole length of the body. The alimentary canal in the intestinal region is well supplied by large vessels arising from the dorsal which apparently end blindly; but in the segments immediately behind the hearts, which have vascular swellings in 16 and calciferous glands in 14 and 15 (Spencer, loc. cit.), these vessels end in a blood sinus below the alimentary canal. The commissurals, if present, are very indistinct along the intestinal region. The dorsal runs forward to the first segment, when it breaks up into very fine branches after giving off a small vessel connecting with the lateral. From 9-2 the dorsal gives rise to a pair

1 Michaelsen, loc. cit., p. 162.

of commissurals in each segment, which pass to the ventral vessel, sending a branch to the ventral body wall and posterior septum of the segment on the way. In 4, 3 and 2, however, the commissurals are very fine, and the vessel to the body wall not apparent, though in 3 there is a large development of branches over the alimentary canal and gland. From 9-5 these commissurals present a constriction, probably marking a valve, about one-third of the distance along their length; and from this point vessels arise running to the alimentary canal wall, and in 5 to the hinder septum of the segment.

In 10, 11 and 12 are a pair of *hearts*, thrown into folds by strong connective tissue, and passing to join the ventral. They are connected with the dorsal by a fine vessel at the posterior part of each segment, but their main origin is from the well-marked *supra-intestinal*, which arises in 12 and runs forward to end over the alimentary canal in 7. It gives off well-marked vessels to the alimentary canal in 12-7, which send branches to the posterior mesentery of the segment, and join the lateral. These branches to the mesenteries are more marked in the segments anterior to the hearts.

The *lateral* is a well-developed vessel along the whole of its length, taking origin in the first segment on the dorsal side of the body, where it breaks up into very fine branches, one of which connects with the dorsal on each side. It sends irregular branches over the alimentary canal in 1, 2 and 3, and in 4 becomes larger, giving well-marked vessels to the posterior septum. From 4 it runs backwards as a very distinct vessel, whose branches to the hinder septa of the segments are very large, and run in close connection with the lower parts of the commissurals in 9, 8, 7 and 6. In 6 and 7 it is connected with its fellow of the opposite side at the anterior end of the segment by a vessel below the alimentary canal (which sends a branch to the anterior septum), and in 5 and 6 it gives branches to this organ, while from 7-12 these are connected also with the supra-intestinal, though there are also smaller branches passing only to the lateral. In 10 the lateral passes below the alimentary canal, and becomes the *sub-intestinal* on each side, receiving branches from the supra-intestinal in 10, 11 and 12, and giving vessels to the posterior septum. It then runs on,

receiving a small vessel from the dorsal in 13, and ends on the ventral body wall in 16.

The *ventral vessel* is not very well developed anteriorly to 13. It receives a commissural in each segment, and breaks up into very fine branches in 1, some of which pass to the dorsal surface and appear to form very fine connections with branches of the lateral. Behind 14 the ventral is small, and sends branches to the body wall in each segment. In section it appears to be connecting with a sinus around the alimentary canal by extremely small vessels. This sinus is supplied by well-marked vessels from the dorsal.

Both dorsal and ventral vessels are unusually thick-walled and muscular in the hinder region of the body.

4.—**Cryptodrilus manifestus**, Fletcher. Proc. Linn. Soc. N.S.W., 1888.

Plate XLI., Fig. 4; Plate XLII., Fig. 7.

Dissection.—Dorsal vessel single, slightly swollen in segments 13, 14 and 15, and running forward to apparently break up in 1.

From 15 backwards it gives off two vessels in each segment closely applied to the alimentary canal. In 14 there is apparently only one of these, while in 13 none arises from the dorsal at all.

In 10, 11 and 12, a pair of *hearts* arise from a double origin at the posterior part of each segment, and pass to the ventral vessel. From the hinder end of segments 9-5 a pair of *commissurals* arise, running parallel to, if not joining with, the lateral or one of its branches for some distance in each segment, and sending vessels to the posterior septum and ventral body wall before joining the ventral. The mesenteries anterior to 7 are very thin, which makes the segmental arrangement difficult to distinguish, but in 5 the commissural gives branches to the alimentary canal as well as those already described for each segment. Anterior to 4, the vessels are small and indefinite, but the dorsal appears to give branches to the alimentary canal and break up in 1.

The ventral vessel is also single, sending branches to the alimentary canal in the segments anterior to 4, and to the ventral body wall from 6 to 1, in which it breaks up. From the anterior end of 10 passing backwards, it gives branches to the ventral body wall, especially well-marked in 10, 11 and 12.

There is apparently *no supra-intestinal*, but in 10, 11 and 12 is a short *transverse vessel*, which is the main origin of the hearts. There is a well-marked branch from this vessel in each segment, also to the calciferous glands, which is connected with the lateral; and vessels pass to the dorsal surface of the alimentary canal, running forward in each of the three segments, but with no definite connection with the transverse vessel of the next. Even in sections, which show the blood supply is thick above the alimentary canal, no definite supra-intestinal can be made out; the only approach to it being between 12 and 13, where a median vessel, apparently taking origin from the irregular blood spaces and in connection with those of the calciferous glands of each side, passes forwards to unite with the transverse of 12.

The lateral arises from the commissural in 5 on each side, and runs forward to break up on the anterior septum of that segment, passing back to join its fellow at the posterior end of 9, through (in one specimen) a glandular organ, from whence it runs on as a single *sub-intestinal*, dividing again at the hinder end of 12, and ending on the posterior septum of 13. From 5-9 its branches pass to the alimentary canal and posterior septum of each segment, the latter vessel having in most cases, as stated, a curious connection with the commissurals, which seems to only involve the outer coats of the vessels.

5.—**Cryptodrilus grandis**, Fletcher. Proc. Linn. Soc. N.S.W., 1887.

Notoscolex grandis, Fletcher.

Plate XLI., Fig. 5.

Dissection.—*Dorsal vessel* single, very slightly swollen in the heart region, running forwards to segment 1, where it divides to two, one passing round to join the ventral on each side.

From 15-20 it gives off a pair of vessels in each segment, supplying the alimentary canal, but their connections with the ventral (if any) have not yet been made out. Behind the wall opening it continues to give rise to a pair of vessels closely applied to the alimentary canal wall on each side in every segment, but their further relations need microscopically examining. In 14 the dorsal gives off one branch to the sub-intestinal, supplying the alimentary canal on its way, and from the back of 13 a pair of *hearts* arise, with a double origin—from the dorsal and supra-intestinal—and run round to the ventral vessel, joining it on its under side, this arrangement being continued till segment 10. As far as can be seen microscopically there are valves in the dorsal vessel at each septum, and also at the origin of the hearts. From 9-2 the dorsal gives off from the hinder part of the segment a pair of *commissural vessels* on each side, and from 9-5 definite branches arise from these to the posterior septum of each segment. The mesenteries in this form are exceedingly thick at the anterior end, and with this fact may probably be associated the great development of small branches arising from all the main vessels in this region. In 4 the commissurals give off on each side a *lateral*, running backwards and forming later on, as usual, the *sub-intestinal*, which seems to end as a marked vessel at the posterior part of 15, but to run on somewhat indefinitely for a short distance behind this. From all around the origin of the lateral, and from the two pairs of commissurals in 2 and 3, small branches arise, supplying the anterior end of the alimentary canal, salivary glands, etc. The lateral gives a definite branch to the hinder septum of the segment in 5-13, which is not so marked in the heart segments as elsewhere; while there is a particularly large development of branches over the upper portion of the alimentary canal in 9. From 6-15 the sub-intestinal receives vessels from the alimentary canal.

The *supra-intestinal* arises in 14, and is double in this segment, and as far as the middle of 13 in the specimen examined. It seems to take origin just where it sends branches to the alimentary canal, and from here forwards as far as 8, it sends a pair of vessels in each segment to supply this organ, and open to the sub-intestinal; while in 6 and 7 it gives smaller

branches to the alimentary canal above which it ends blindly in 6.

The ventral vessel runs forwards and breaks up at the anterior end, sending a branch to join the dorsal as described, and behind the region of the hearts it gives a very definite pair of vessels in each segment and the ventral body wall running along the septum.

6.—**Cryptodrilus saccarius**, Fletcher. Proc. Linn. Soc. N.S.W., 1887.

Plate XLI., Fig. 6, and Plate XLII., Fig. 8.

Dorsal vessel single, slightly swollen in segments, 14-10. It passes forwards to first segment, becoming very indefinite in the anterior two or three, but apparently joining the ventral in 1. From 14 backwards it gives off a commissural vessel on each side, which supplies the alimentary canal, but in all cases in this form the connections with the ventral vessel are fine. There are four pairs of *hearts*, the last arising in the posterior part of segment 13, from a double origin—by a fine branch from the dorsal and a much more definite one from the *supra-intestinal*. This latter makes its appearance in segment 13, and is very marked, giving large branches to the calciferous glands, which are conspicuous structures, in segments 13-9. It apparently becomes discontinuous in segment 12, but on examining microscopically, is found to be represented by an exceedingly fine vessel between the hearts in 11 and 12. It ends blindly above the alimentary canal in segment 8.

From segment 9 forwards the dorsal gives off a pair of commissural vessels at the posterior part of each segment, that in 9 being very well marked. From 9-6 the commissurals give branches to the posterior septum of the segment, that in 6 being small. Those commissurals in 2, 3 and 4 are very indistinct, but apparently join the ventral vessel, while that in 5, after giving a branch to the alimentary canal, joins a marked *lateral*, which in its turn sends a branch to the ventral vessel. It also joins its fellow of the opposite side under the alimentary canal in segment 5, and sends a branch forward to the alimentary

canal wall. The excessive development of blood vessels is a marked feature of this segment, and is probably associated with the well-marked "salivary gland." The commissural in 4 also sends a branch back to break up on the alimentary canal.

The *lateral* is very large at its origin, though its connection with the commissural is somewhat faint. It runs backwards, sending branches to the posterior septum of the segment in 6, 7, 8 and 9, and in 9 receives vessels from the calciferous gland. In the anterior part of 10 it joins its fellow of the opposite side by a single vessel, and from this point two continuations of the laterals run back closely applied to the ventral wall of the alimentary canal, and forming the *sub-intestinals*. In 10, 11, 12 and 13 vessels from the calciferous glands open to these.

The *ventral* vessel is single along its length, and becomes inconspicuous at its anterior end. In the region of the calciferous glands, which are really highly vascular enlargements of the alimentary canal, the branches from the supra-intestinal are closely applied to the wall of the gland, and send vessels to its villus-like projections on the internal surface of the gland. The blood is then collected up with definite vessels (Br. Cal.), passing to the sub-intestinal on each side. (See Fig. 8.)

EXPLANATION OF PLATES XL.-XLII.

Figs. 1-6.—Diagrams of side views of the cephalic blood vessels of the earthworms named.

Fig. 7.—Dorsal view of the vessels at the origin of one of the hearts in *C. manifestus*.

Fig. 8.—Low power view of the blood supply to and from a calciferous gland of *C. saccarius*.

REFERENCE LETTERS.

Al. C. - - Alimentary canal.

B. - - - Branch from ventral vessel to septum and body wall.

B. A. - -	Branch from commissural vessel to alimentary canal.
B. C. - -	Branch from commissural vessel to septum.
B. D. - -	Branch from dorsal to heart.
B. S. - -	Branch from sub-intestinal or lateral to septum.
Br. A. - -	Branch from supra-intestinal to alimentary canal.
Br. Cal. -	Branch from calciferous gland to sub-intestinal.
br. Cal. g. -	Branch from supra-intestinal to calciferous gland.
Br. W. -	Branch from commissural to septum and body wall.
D. S. - -	Branch from dorsal to septum.
D. V. - -	Dorsal vessel.
Ht. - -	Heart.
Mes. - -	Mesentery.
Pl. - -	Plexus on alimentary canal.
Pl. S. - -	Branch from plexus to septum.
S. I. V. -	Supra-intestinal vessel.
Sub. I. V. -	Sub-intestinal vessel.
V. V. - -	Ventral vessel.

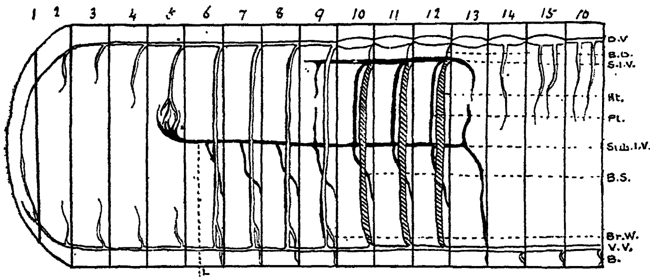


FIG. 1. MEGASCOLEX AUSTRALIS.

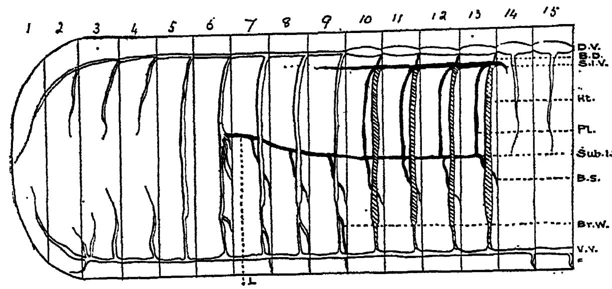


FIG. 2. CRYPTODRILUS CAMDENENSIS.

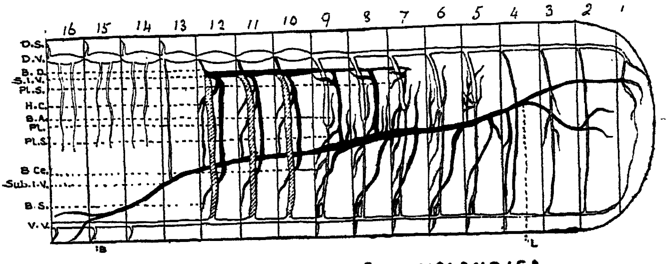


FIG. 3 NOTOSCOLEX QUEENSLANDICA.

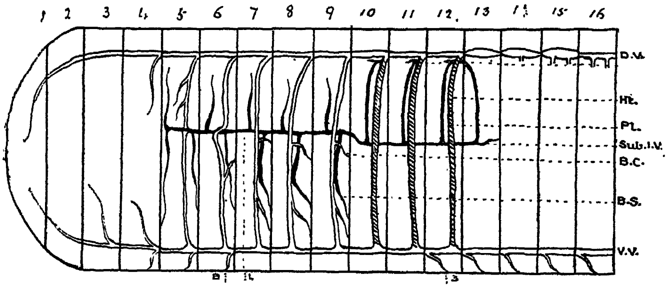


FIG. 4 CRYPTODRILUS MANIFESTUS.

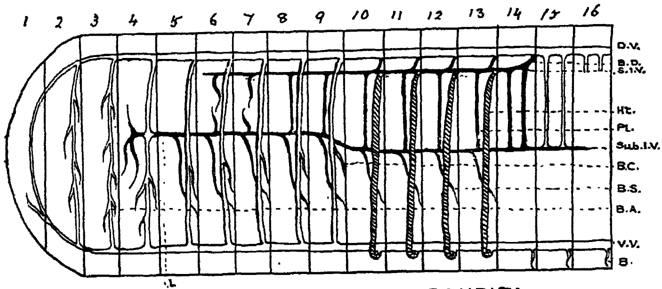


FIG. 5 CRYPTODRILUS GRANDIS.

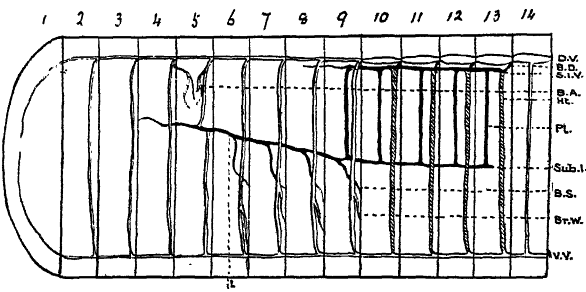
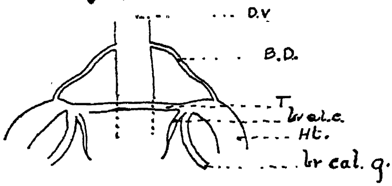


FIG. 6. CRYPTODRILUS SACCARIUS

Fig. 7



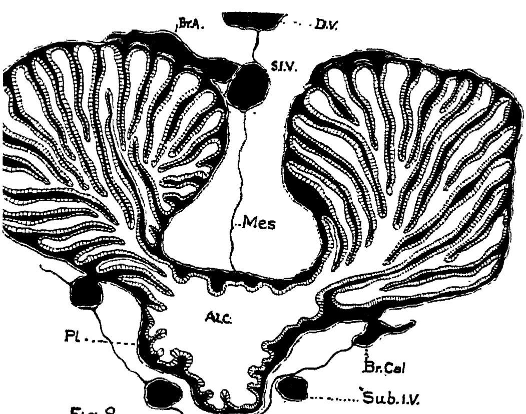


Fig. 8.

[PROC. ROY. SOC. VICTORIA, 22 (N.S.), PT. II., 1909.]

ART XVI.—*Note on the Accessory Glands of Cryptodrilus saccarius (Fletcher).*

BY GWYNNETH BUCHANAN, B.Sc.

(With Plate XLIII.).

[Read 9th December, 1909].

These structures are present close to the male and female genital openings, though they are more numerous near the latter. Their arrangement seems to be in four main groups, one between segments 12 and 13, one on 18 between the male openings, one between 21 and 22, and one between 22 and 23. In one specimen, however, that in which the groups of gland cells were most numerous on 18, there was a very small and inconspicuous structure between 18 and 19.

The accessory gland between segments 12 and 13 may be taken as typical, since they all have the same histological structure, differing only in the number of patches of glandular cells in one group. On the mid-ventral surface, on the depression between the segments, is an oval area, bounded by swollen lips, in the middle of which are two rounded patches, marking the glands themselves. As a rule there are two of these patches (Fig. 1), but they may be more numerous, as many as four in segment 18 being observed in one specimen (Fig. 2), while occasionally, in the glands posterior to the male opening, there is only one. It seems probable that the condition of the accessory structures varies with the age of the worm, their number, however, being practically constant. In section the glandular patches are seen to be flask-shaped structures, composed of swollen, mucus-secreting cells, (Fig. 3, g.c.), elongated at right angles to the surface, and apparently each opening independently to the exterior. The circular muscle of the body wall becomes practically obliterated at this point, while glands of what appear to be connective tissue or muscle fibres pass out among the epidermal cells, which are here elongated, as compared with

the ordinary columnar of non-glandular areas, and in among the longtitudinal fibres (Fig. 3).

Accessory copulatory structures are common among Oligochaetes, being called by various names, and Fletcher describes their external appearance in *C. saccarius*,[1] but I have not found their minute structure mentioned elsewhere. Spencer[2] points out a large development of glandular cells in the clitellar region of *Megascolides australis*, evidently similar in histological structure to those of the accessory glands in *C. saccarius*, but differing in not being grouped to form separate organs. He also notes the penetration of the epidermis by fibres, but describes the epidermal cells as being shorter than elsewhere, while in *C. saccarius* they are longer around the glandular patch. It is evident that the function of these secreting cells in the clitellar region is connected with the formation of the cocoon; the fact of their being collected into patches around the genital openings, however, seems to point to their function here being principally to secrete mucus, which would aid in the passage of the reproductive elements to the cocoon and of the body of the worm through it without friction.

Since going to press I find that a very similar set of accessory structures has been described and figured by Miss G. Sweet (Linn. Soc. Journ. Zool., vol. xxviii.) in *Digaster excavata* and *Megascolex dorsalis*.

EXPLANATION OF PLATE XLIII.

Fig. 1.—External appearance of an accessory gland of *C. saccarius* between segments 12 and 13.

Fig. 2.—The same around the male opening, segment 18.

Fig. 3.—Low power drawing of the accessory glands and associated structures between segments 12 and 13 in *C. saccarius*. (Outline with camera lucida).

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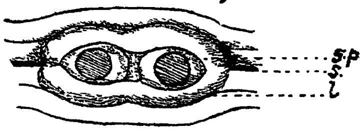
1 Proc. Linn. Soc. N.S.W., 1889.

2 Transactions of Roy. Soc. Vict., vol. i., pt. i., 1888. The Anatomy of Megascolides australis.

Fig. 1.



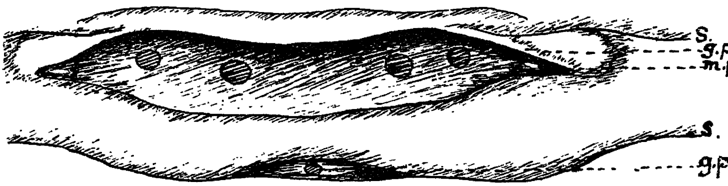
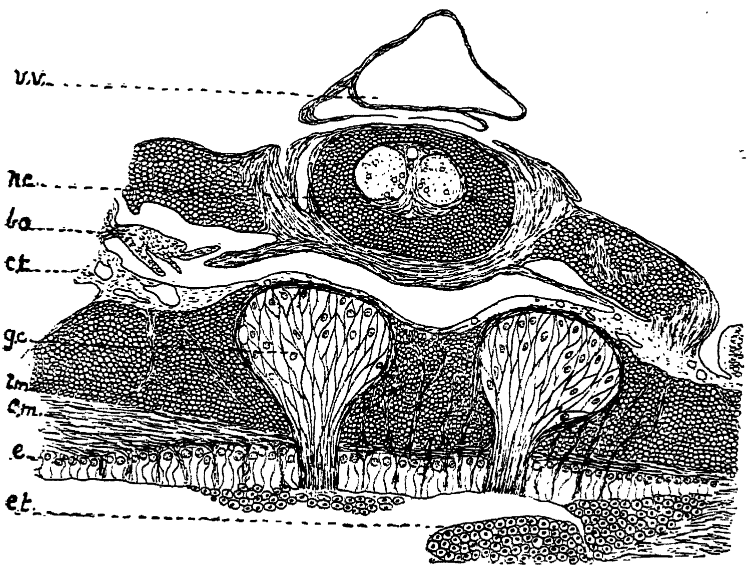


Fig. 2.

Fig. 3.



REFERENCE LETTERS.

b. o.	=	Base of ovary.
c. m.	=	Circular muscle.
c. t.	=	Connective tissue.
e.	=	Epidermis.
e. t.	=	Epidermis cut transversely.
g. c.	=	Gland cells.
g. p.	=	Glandular patch.
l.	=	Lip of accessory gland.
l. m.	=	Longitudinal muscle.
n. c.	=	Nerve cord.
m. p.	=	Male pore.
s.	=	Line marking septum.
v. v.	=	Ventral vessel.

[PROC. ROY. SOC. VICTORIA, 22 (N.S.), PART II., 1909.]

ART. XVII.—*Contributions to our Knowledge of Australian Earthworms.*

THE NEPHRIDIA.

BY FREDA BAGE, M.Sc.,

Government Research Scholar in the University of Melbourne.

(With Plates XLIV.-XLVII).

[Read 9th December, 1909].

For some years past Professor Spencer and Mr. J. J. Fletcher have been engaged in describing a large collection of Australian earthworms, chiefly those of the eastern and south-eastern coastal districts.[1] As their collections have increased in size they have found it necessary to describe new species, putting them temporarily into certain genera until the classification of the earthworm fauna should be more satisfactory. To prepare the way for such a classification much anatomical work is needed, and at present a series of investigations is being carried out in the Melbourne University. Dr. Georgina Sweet and Miss Gwynneth Buchanan have published work on the spermiducal glands and bloodvessels respectively; Miss Janet Raff is engaged on work on the alimentary canal, and at the suggestion of Professor Spencer I have undertaken the part in connection with the nephridia. The work has been done in the Biological Laboratory of the University of Melbourne, and I take this opportunity of thanking Professor Spencer for the use of his large collection of Australian earthworms and for his advice and help on all occasions.

The genera dealt with are *Megascolex*, *Diporochaeta*, *Digaster*, *Perissogaster*, *Megascolides*, *Woodwardia*, *Notoscolex and Fletcherodrilus*, though only one or two species of each have been examined. In most of the forms the original description stated whether they

1 A large number of earthworms from South-Western Australia has recently been described by Professor W. Michaelsen in his work "Die Fauna Südwest-Australiens," 1907.

were mega or micronephric, or sometimes plectonephric, and I have endeavoured to supplement this with some account of the general distribution of nephridia throughout the body, and where possible with microscopic structure. Throughout I have used the terms meganephric and micronephric, the latter in preference to Benham's word plectonephric, used in most of the original descriptions, but which he has himself since discarded in favour of micronephric.

The structure and arrangement of the nephridia vary to an enormous extent, but there are points of resemblance in some, and with further work on the Australian forms it appears that the nephridia may be of much use for systematic purposes.

For convenience I have adopted the nomenclature and classification of the genera used by Michaelsen in his account of the Oligochaeta of South-west Australia.[1]

1.—**Megascolex dorsalis**, Fletcher;
syn. Perichaeta dorsalis, Fletcher (8), p. 618.

No nephridiopores can be seen externally.

Both micro and meganephridia are present, a condition which Beddard (2), p. 370, regards as characteristic of the genus Megascolex, though as far as I can ascertain, meganephridia have not been figured before for this species.

Macroscopic Structure.—On dissection micronephridia are seen to be present throughout all the segments of the body. These are described by Fletcher (8), p. 618, as minute inconspicuous tufts of tubules. They are arranged somewhat irregularly over the body wall in the anterior segments of the body, becoming less numerous in the posterior parts, where the meganephridia are situated, and being arranged more or less regularly in a single row. In addition to these micronephridia there is a distinct series of well-developed meganephridia which are not mentioned by Fletcher or Spencer. These are absent from the segments anterior to the male pores, but from this point to the posterior end of the body there is a pair on the ventral surface of each segment with definite funnels opening on either side of the nerve cord. There is in this species also

1 Michaelsen, "Die Fauna Südwest Australiens—Oligochaeta," pp. 117-232, 1907.

a curious additional pair of meganephridia present on the dorsal surface of the more posterior segments of the body. Each of these dorsal nephridia also has a well-developed funnel. The arrangement of the meganephridia was examined in one specimen which consists of 120 segments. [Fig. 1.] The micronephridia were present in every segment, ventral meganephridia in segments 21 to 120, while the dorsal meganephridia were present only in segments 50 to the posterior end. The parts of the nephridia were too small to be made out by dissection, but a fine thread could be seen connecting the two meganephridia. [Fig. 4.]

Microscopic Structure.—By means of series of sections the structure of the meganephridia was made out in part. Both dorsal and ventral tubules appear to be similar in structure, and to consist of the same series of parts. The structure of the funnel is different from that of any other species examined, the cells composing it being very few in number, apparently only five, and extremely large in size. [Fig. 2, c.] These are, as usual, ciliated, and the nuclei are distinctly seen in stained sections. The cells have their long axes parallel with the length of the body, and are somewhat irregular in shape; thus there is no arrangement to be compared with that of the regular marginal cells of other species. The funnel leads into an intracellular duct [Fig. 2, d.i.], the tubule containing which, after passing through the septum to the next posterior segment, divides into two portions [Fig. 3], each of which contains a mass of coiled intercellular ducts. A very fine intracellular duct joining the dorsal and ventral nephridia passes round the alimentary canal attached to the face of the anterior septum by a fine mesentery. The ventral nephridium apparently opens to the exterior by a fine duct which passes out through the muscles. No trace, however, could be found of any duct opening directly from the dorsal nephridium. This seems to point to the probability that the dorsal nephridium is simply a portion of the ventral one, which has, together with the spermathecae, come in this form to lie dorsally, and has acquired a secondary opening into the body cavity.

The micronephridia, although extremely minute, are very numerous, and are attached to the body wall of every segment

except the first. They are arranged irregularly and have no funnels, the tubule being simply a short coil containing an intracellular duct which continues from one nephridium to another, the exact connection of which, with irregularly placed minute openings to the exterior, I have been unable to make out. There is, however, as far as I have seen, no continuation of these ducts from one segment to another. In this species there are no peptonephridia.

2.—**Megascolex fielderi**, Spencer;
syn. Perichaeta fielderi, Spencer (16), p. 19.

No nephridiopores are visible.

Both micro and meganephridia are present, the presence of the latter being indicated by the occurrence of funnels in certain segments of the body. Glandular tufts of nephridial tubules are present in the anterior segments, which are regarded as doubtful peptonephridia by Professor Spencer (16), p. 19, but which do not appear in my sections to open into the alimentary canal.

Macroscopic Structure.—When the earthworm is opened from the dorsal surface, nephridia are seen to be present in great numbers in all the segments, especially in the clitellar region. From about the twentieth segment to the posterior end of the body they are arranged in a fairly definite row in each segment, and are more or less attached to one another. No funnels can be seen in the anterior part of the body, but towards the posterior end the funnels become more and more numerous, as many as fourteen being counted in one segment. At the same time the characteristic row of nephridia does not alter. The position of the nephridial funnels seems to be quite irregular, and they vary in number in the different segments. In one specimen of 134 segments the funnels were counted. The most anterior one occurred in segment 93 on one side only. This was followed by one here and there [Fig. 5, F], back to segment 110, after which there were numerous funnels in each segment. The presence of the funnels does not seem to entail any perceptible difference in the size or number of the nephridia in each segment. Throughout the body, posterior to

segment 20 the nephridia are irregular in shape, and appear to be connected with one another by a loose band of tissue which, in its turn, is connected with the anterior septum of each segment. [Fig. 6.]

Microscopic Structure.—A series of sections confirms the general arrangement seen by dissection. Towards the posterior end of the body, the nephridia, into which the funnels open, are connected with one another by means of the loose connective tissue noted above. Through this ramify many ducts [Fig. 7], which soon pass off singly through the longitudinal muscles to what seems to be a sinus between the two layers of muscles. From this sinus branched ducts lead again to the exterior. I was unable to trace any one duct right through to the external opening, as they form such a confused network. Further, from my sections I could not decide whether or not there was a connection of the ducts from segment to segment, but apparently the sinus was continuous through all the segments examined. At the very anterior end there is a mass of nephridial tubules, one on either side of the pharynx, which were recognised by Professor Spencer as doubtfully peptonephridia. I have not been able to find any ducts opening from these to the alimentary canal, and Miss Raff, who is working on the structures connected with the alimentary canal, has not only failed to discover any connection with the pharynx, but has traced ducts from the tufts which open to the exterior, so that they must be regarded as a tuft of micronephridia, and not as peptonephridia.

3.—Diporochaeta davallia, Spencer (17), p. 52.

The nephridiopores could not be distinguished with the naked eye, but on dissection the ducts from the nephridia to the exterior are seen to open at the level of the interval between the fourth and fifth setae from the ventral surface; that is, about halfway between the mid-ventral and mid-dorsal lines. (See also Spencer (6), p. 52.)

The nephridial system is meganephric.

Macroscopic Structure.—There are, except in the first and second segments, one pair of meganephridia in each segment.

In the first segment there are no nephridia, and in the second, a thick tuft of what are apparently micronephridia take the place of the ordinary pair. No funnel could be seen opening from this mass of tubules. Behind these two segments a conspicuous pair of meganephridia is situated in each segment. Throughout the body these nephridia appear to consist of the same parts [Fig. 8], though there is some variation in the thickness and length of the several coils in different regions. The nephridia, towards the anterior end, seem to be thicker walled and more closely coiled than those behind the spermiducal glands. The funnel [Fig. 8] is connected by a fine duct passing through the septum to a large coiled portion [Fig. 8, c.n.], averaging 3 mm. in length. One coil, the same in each nephridium behind segment 18, is curiously dark in colour, apparently containing pigment [Fig. 8, p.c.n.]. A fine thread passes out of the coil and along the body wall, entering it between the fourth and fifth seta from the ventral surface.

Microscopic Structure.—The funnel is relatively large, and is formed by columnar ciliated marginal cells which appear to be twenty in number, and are arranged in a very definite way in a single row. [Fig. 9, c.m.] From the funnel ciliated cubic cells are continued for a very short distance, and the lumen surrounded by these soon passes into the usual intracellular duct.

The pigmented coil mentioned above is well seen when the nephridium is mounted whole in glycerine. In section, the pigment appears to be present in the form of granules laid down in the substance of the cells lining the coil, the lumen of which is intracellular. [Fig. 10.] The nuclei are well seen in some of the sections. [Fig. 10, nucl.] Apart from the presence of the pigment granules, the histology of this coil is similar to that of the rest of the larger coils of the nephridia, being lined by large clearly-nucleated cells. There is no well-marked muscular duct, but its place is taken by a long intracellular straight duct [Fig. 8, i.d.], which, after traversing the segment for a short distance, enters the muscles and passes out through them to the exterior almost directly, the external opening being very small.

4.—Diporochaeta grandis, Spencer (17), p. 63.

Nephridiopores could not be distinguished in the one specimen available.

This species is meganephric.

Macroscopic Structure.—One pair of meganephridia occur in each segment after the first. These are arranged in the same coils throughout all the segments of the body, but change somewhat in character towards the anterior end. The most noticeable point about the nephridia is a curious single marginal duct [Fig. 11, m.d.], which passes in a definite way round a portion which is apparently the vesicle (V ?).

Microscopic Structure.—Under the microscope the above duct is seen to be coiled in certain parts, straight in others, and intercellular. It forms a loop surrounding a definite flat layer or layers of connective tissue [Fig. 11, c.t.), and is quite conspicuous. There is some indication of the presence of a muscular vesicle [Fig. 11, V?], but as no sections were available, that is doubtful. The funnel is very definite in shape, being surrounded by a well-defined row of marginal cells. Just where the cavity of the funnel passes into the intracellular duct there is a curious mass of cells [Fig. 11, m.c.], quite definite in shape, and arranged round the preseptal portion of the intracellular duct. This appears to be comparable with the cells occurring in *Lumbricus*, figured by Benham (6), p. 297, and regarded by him as coelomic epithelial cells.

In the specimen of *D. grandis* examined, enormous numbers of small white spots appeared to be attached to nephridia. On examination these proved to be colonies of sporozoa, though I have not been able to identify them.

5.—Digaster armifera, Fletcher (6), p. 947.

No nephridiopores were visible.

The nephridial system is micronephric throughout, the anterior nephridia being modified to form peptonephridia in the first four segments.

Macroscopic Structure.—On opening the body wall micronephridia are seen to be present throughout all the segments. They take the form of small tubes attached to the body wall or

to the segments. They are much more numerous towards the anterior end, where they are arranged quite irregularly, giving a velvet-like appearance to the body wall. Towards the posterior end they become more regularly arranged, forming what appears to be a single row in each segment. Tufts of tubules attached to the alimentary canal, and regarded as pepto-nephridia by Beddard, are present in the first three segments, and are attached to the ventral surface of the alimentary canal.

Microscopic Structure.—The nephridia in the hinder part of the body, from where my series of sections were taken, proved to be infested with sporozoa. These lay in masses round the nephridia and septa, completely disguising the histology of the nephridium, and apparently causing the familiar appearance of the tissue lining the body cavity. No sporozoa were present in the circular or longitudinal muscles.

6.—**Perissogaster excavata,** Fletcher (7), p. 383; syn. Digaster excavata, Fletcher.

No nephridiopores were visible.

The nephridia are micronephric, the anterior nephridia in the first four segments being modified to form peptonephridia, as in *Digaster armifera.*

Macroscopic Structure.—Again, as in *D. armifera*, micro-nephridia are present throughout, but are much more numerous towards the anterior end of the body. (Feltcher (8), p. 383.) Those in the first four segments are attached to the alimentary canal wall, and probably function as peptonephridia. A few nephridia in the three posterior segments of the body seem to remain attached to the alimentary canal near the anus, and are in all probability anal nephridia (c.f. Beddard (2), p. 49).

7.—**Megascolides australis,** McCoy (13); syn. Notoscolex gippslandicus, Fletcher.

This form has been fully described by Professor Spencer in his Monograph on the Anatomy of Megascolides australis (14), so there is no need to describe the nephridial system in full,

but a short description is included here to complete the series I have worked, and diagrams are given. So far as I can ascertain there are only one or two minor points which appear to differ from the work published before.

No nephridiopores are visible.

Micro and meganephridia are present, also peptonephridia.

Macroscopic Structure.—Peptonephridia are present in segments 1-4; micronephridia in every segment after the fourth, attached to the outer walls of the segments. Meganephridia are present in addition, only in the more posterior portion of the body. In one specimen examined there were 330 segments, and typical meganephridia occurred from segment 180 to the posterior end, one pair in each segment. From segment 180 forwards [Fig. 12] a few large nephridia [Fig. 12, N^1] are present, but only here and there. These, though quite distinct from the micronephridia in size and position, have for the most part no funnels, but are still connected with the anterior septum. No nephridial funnels could be seen besides the single ones on either side of the nerve cord.

Microscopic Structure.—By means of sections the structure and arrangement of the various nephridia, and the ducts connecting them, can be more clearly ascertained. At the hinder end of the body there is in each segment a pair of meganephridia, each consisting of a funnel, a short, straight tube, and a coiled part, present on each side of the nerve cord. The funnel, as usual, opens into the segment anterior to the one in which the main part of the nephridium is situated; and through the wall of this latter segment a fine duct communicates with the exterior. [Fig. 13, N.d.] There is also present in the same segment many micronephridia [Fig. 13, n^1, n^2, n^3], each of which gives off a single definite duct [n^1d., n^2d., n^3d.], which passes through the muscles of the body wall to the exterior, though it has apparently no internal opening. The ducts from both micro and meganephridia pass out singly between the blocks of longitudinal muscle fibres [Fig, 12, n^1d.), or through the fibres composing the block [Fig. 12, n^2d.], and, branching among the circular muscles, form a regular network [n.c.l.] from which small single ducts pass, opening at irregular intervals on to the surface. Further forward, where the meganephridia

become irregular, there is a somewhat different arrangement, as the ducts from the micro- and meganephridia form a network [Fig. 14, n.i.] before passing out through the longitudinal muscles.

In no case could I find any connection from one segment to another by means of ducts, and though Professor Spencer (14) figured it, he was uncertain of its existence.

8.—Woodwardia gippslandica,[1] Spencer; syn. Cryptodrilus gippslandicus.

Nephridiopores not very distinct, but, after careful examination, are seen to be present opposite and anterior to the third seta on each side of the body in each segment after the second, about halfway between the dorsal pores and the midventral line.

Meganephric.

Macroscopic Structure.—On dissection, one pair of meganephridia is seen to be present on the ventral surface of each segment, with the exception of the first and second. The funnel of each [Fig. 16, F.] lies close to the nerve cord in the ventral line. From the funnel a fine cord leads to a coiled mass of tubules, from which apparently a second fine duct passes off to a large muscular vesicle or bladder [Fig. 17], which opens to the exterior just anterior to the third seta. The vesicle is thin walled and transparent. The nephridia appear to be of the same structure all through the body.

Microscopic Structure.—On examining the nephridia of this form histologically, we find that the funnel is extremely small in relation to the size of the nephridium. The actual cells composing it were rather difficult to determine, but as far as could be ascertained they were marginal cells, columnar in shape, and, as usual, ciliated. From the funnel an extremely fine intracellular [Fig. 17, d.i.] duct passes through the septum to a large mass of definitely coiled tubules [17 c.n.]. From this mass is given off a single duct, intracellular again [V.d.], opening into the muscular bladder [V], which is, as in several other species examined, without doubt intercellular. This opens in its turn to the exterior, the opening [O.N.] being, as indicated by the

1 Michaelsen, ibid.

small size of the nephridiopores, by a fine duct, passing from the vesicle, through the longitudinal and circular muscles, to the exterior, and opening near the anterior border of each segment. The cells of the epidermis are turned in at the opening, lining it for a short distance. I can find no trace of special muscles, as in *Woodwardia cooraniensis*, which could control the opening to the exterior. In this form, also, the vesicle [Fig. 17] has no caecum, the opening to the exterior being at the end of the bladder, away from the nerve cord.

9.—Woodwardia cooraniensis,[1] Spencer;

syn. Cryptodrilus cooraniensis, Spencer (17).

Nephridiopores clearly marked. Though the openings in the many specimens vary somewhat in position in regard to the setae in the first five or six segments, they agree in being alternate down the rest of the body. The general arrangement seems to be that shown in the figure [Fig. 18], Spencer (17). The first three nephridia in segments 2, 3 and 4, open opposite the fourth seta, fourth, fifth and sixth opposite the third seta, seventh opposite fourth, eighth opposite second, and the rest alternating in position opposite fourth and second setae.

The nephridial system is meganephric.

Macroscopic Structure.—One pair of meganephridia is present in each segment after the first, and there are no micro- or pepto-nephridia. The most noticeable feature in the arrangement of the nephridia in the body is the alternation in the arrangement of the various parts of the nephridia to correspond with the alternation in position of the external openings. The nephridia are arranged in two distinct sets, the vesicle, which is of large size, being conspicuously placed towards ventral [Fig. 19, A.] or dorsal [Fig. 19, B.] line, as the nephridiopores open opposite the second or fourth seta respectively. Very little more than the general arrangement of the nephridia could be seen by dissection, and the position of the funnels, which are extremely small, could not be determined.

1 Michaelsen, ibid.

Microscopic Structure.—Transverse serial sections of this form show the funnel to be very small, and, unlike the nephridiopores, constant in position, being situated between the first and second setae from the midventral line on each side. [cf. Benham, (4)]. The general arrangement shown in the figure (20) is reconstructed from a series of sections. As can be seen, the same parts are present in both nephridia, the coils differing in length, according as the vesicle opens dorsally [Fig. 20, O.N.B.] or ventrally [O.N.A.]. The histology of one of my series was particularly good, so that the structure of the various parts could be worked fairly completely. The funnel in very small, formed by a few marginal cells, columnar in shape, and ciliated. The tube leading from this divides into two parts, the thinner one of which passes at once to the vesicle, being shorter in nephridium A than in B; while the thicker one in both nephridia coils in definite ways and ends blindly. In section, the tube leading from the funnel is seen to contain an intracellular duct which, at the point X passes into the coiled tube c.n. [Fig. 20]. It continues as a straight lumen as far as the blind end [Fig. 20, Y.], where a section shows clearly that the lumen turns back on itself, and becoming somewhat wider, coils slightly in the thickness of the tube until it reaches point X again, where the duct passes as a single straight lumen to open into the vesicle [o.v.]. This arrangement is strictly comparable with that of the nephridium of *Lumbricus* described by Benham (3), the intracellular straight lumen being Benham's "narrow tube," while the wider coiled part resembles the wide tube described by him. The vesicle also is extremely thin walled, and apparently composed of a single layer of irregular muscle cells lined by very thin epithelial cells. The opening of the vesicle to the exterior is extremely well-marked, the lining of the vesicle distinctly changing from flattened to cubic epithelial cells, which, in their turn, give place to the columnar cells continuous with those of the external surface of the body [Fig. 21] and, like them, covered by a thin cuticle. The arrangement of the muscles is characteristic, as, in addition to the ordinary circular and longitudinal muscle bands, there is a distinct group of muscle fibres round the external opening, which appears to form a "sphincter" controlling the opening of the nephridium to the exterior [Fig. 21].

There is no trace at all of any network of nephridial ducts in this species, each nephridium being absolutely distinct from all others, with its own openings, interior and exterior.

In several specimens examined for the nephridia, only those of the anterior half of the body were in good preservation, the rest of the body being infested with some sporozoan form, which was present in such numbers as to disguise completely the histology of the nephridia when sections were cut.

10.—**Notoscolex queenslandica**,[1] Spencer;
syn. Cryptodrilus queenslandica, Spencer (5).

No nephridiopores visible.

Nephridial system micronephric.

Macroscopic Structure.—The micronephridia are present in every segment of the body with the exception of the first. Towards the anterior end, in segments four to five, they are extremely minute and numerous, and are arranged quite irregularly, lining the whole of the inner wall of the segment. Behind the first few segments, however, though still very minute, they are no longer indefinitely arranged, but form a single row in each segment attached to the wall, about the centre of the segment, between the two branches of the nerve cord.

11.—**Fletcherodrilus unicus**, Fletcher, var. major, Spencer (17).

The nephridiopores are well marked and are situated opposite and anterior to the fourth seta from the midventral line on either side of the body, except those on segments 2, 3 and 4, which are slightly dorsal to the setae. [Fig. 22.] Fletcher (15), p. 1540.

Nephridial system meganephric.

Macroscopic Structure.—On dissection one pair of meganephridia is seen to be present in each segment after the first. There are no micronephridia or peptonephridia present. The nephridia of the anterior segments of the body are very much

1 Michaelsen, ibid.

larger, with proportionally smaller and more muscular-looking vesicles [Fig. 24], while those of the rest of the body have much smaller coils, but the vesicles are large and have transparent walls. [Fig. 25.] The vesicles form a most conspicuous feature of the nephridial system, and the nephridia were of such large size that their general arrangement could be seen microscopically.. [Fig. 23.]

The parts seen are closely similar to the nephridia of *Woodwardia cooraniensis*, though in the case of *F. unicus* there is no alteration in the arrangement of the nephridia.

The funnel (F) lies near the midventral line of the body, opening between the ventralmost seta and the nerve cord, and connecting by a fine thread passing through the septum, with two portions—(1) a somewhat coiled tube which ends blindly; and (2) a fine duct which connects with the large muscular vesicle, which in its turn opens to the exterior.

Microscopic Structure.—An examination of sections of this earthworm shows that the funnel is composed of a single row of marginal cells, columnar in shape, and ciliated. Figure 26 shows diagrammatically the various parts present. From the funnel (F) a duct leads by means of a fine intracellular lumen connecting with the main part of the nephridium, as mentioned above. [Fig. 25, d. i.] This lumen can be distinctly traced through the greater part of the long coil figured as c.n. [Fig. 26]. But, as well as this somewhat straight lumen, there is a coiled tube present, which apparently passes back from the blind end (Y) along the whole length of the coil (c.n.), and then continues as the fine intracellular duct (v.d.) leading to the bladder. Unfortunately the histology of my series was not very good, and I was unable to see the transition between the cells forming the duct (v.d.), and the flattened cells forming the wall of the bladder itself. The opening of the vesicle to the exterior is provided with a number of flattened, unstriated, vesicle cells, forming a sphincter. The very thin flat cells lining the vesicle, pass into cubic epithelial cells, and these into the ordinary epithelial cells of the outer body wall. This species somewhat closely resembles *Woodwardia cooraniensis* [Fig. 21], except that in the latter there is no such sphincter muscle present as I have described above.

12.—**Fletcherodrilus unicus**, Fletcher;
syn. Cryptodrilus ? unicus, Fletcher (7), p. 1540
C. purpureus, Michaelsen (11), p. 3
Cryptodrilus ? purpureus, Fletcher (8), p. 990
C. ? fasciatus, Fletcher (8), p. 988
Fletcherodrilus unicus, Michaelsen (12), p. 29.

After careful examination of this form, and cutting series of sections, I can find no difference between its nephridia and those of Professor Spencer's variety, *F. unicus, var major*. [Also see Spencer (17)].

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EXPLANATION OF PLATES.

Fig. 1.—*Megascolex dorsalis.* Diagram to show relative positions of dorsal and ventral meganephridia, and the segments in which they occur.

2.—Diagrammatic section of one of same through funnel, compiled from three consecutive sections to show the large ciliated cells (c) forming the funnel.

3.—Dorsal meganephridium of same.

4.—Diagram of posterior segments of the body, with dorsal and ventral meganephridia and the duct (d.c.) connecting the two.

5.—*Megascolex fielderi.* Diagram to show number and position of the funnels in one specimen on one side of the body. The body wall is represented as opened out.

6.—Drawing of same to show nephridia in situ, from posterior end of body.

7.—Somewhat diagrammatic transverse section through body wall. Shows arrangement of nephridial ducts passing out through the muscles to the exterior, and the connective tissue joining the nephridia.

8.—*Diporochaeta davallia.* Drawing of nephridium to show relative positions of the coils, with the pigmented coil (p.c.n.) and the fine intracellular duct (i.d.) opening to the exterior.

Fig. 9.—Funnel of same, showing arrangement of the 20 marginal cells, and the cubic-shaped cells lining the duct from the funnel.

10.—Somewhat diagrammatic transverse section through coils of a nepridium, showing pigment granules (p.g.) in the cells lining the pigmented coil.

11.—*Diporochaeta grandis.* Drawing of nephridium, mounted whole in glycerine.

12.—*Megascolides australis.* Diagram of arrangement of meganephridia in part of a specimen. From 160 to 180 only a few large nephridia are present, most of which (N^1) though attached to the anterior septum, have no funnel.

13.—Diagrammatic transverse section of same near posterior end of body, to show arrangement in one section of the mega- and micronephridia and the ducts for them.

14.—Diagrammatic longitudinal section of same where meganephridia are beginning to become irregular, showing arrangement of ducts from mega and micronephridia, and their connection on their way to the exterior.

15.—Diagrammatic longitudinal section showing same near posterior end.

16.—*Woodwardia gippslandica.* Diagram of five meganephridia in situ on left-hand side of body, to show relative positions and size of funnel (F), nephridial coils (c.n.), vesicle (V), and opening to exterior.

17.—Diagrammatic nephridium of same, showing relation of the several parts to one another.

18.—*Woodwardia cooraniensis.* External view, showing positions of openings of the nephridia and their relation to the setae.

19.—Semi-diagrammatic drawing near posterior end of body of same, to show six nephridia in situ with those on right-hand side of body, opening opposite 2nd seta (A) and opposite 4th seta (B) alternately.

20.—Enlargement of same, showing two consecutive nephridia and their various parts.

Fig. 21.—Section of opening of nephridium of *W. cooraniensis* to exterior, showing arrangement of muscles, and the gradual change in character of the epithelium from the ordinary external cells to the flattened cells lining the vesicle.

22.—*Fletcherodrilus unicus, v. major.* External, showing positions of openings of the nephridia to the exterior, with regard to the setae.

23.—Diagrammatic drawing of same, to show six nephridia in situ on left-hand side of body, with the position of funnel, vesicle, coils and opening to exterior in relation to the setae.

24.—Drawing of left-hand nephridium of segment 6 in situ, showing relatively small size of the vesicle, which is thick-walled.

25.—Drawing of a left-hand nephridium near posterior end of body in situ, showing large thin-walled vesicle, and relation of coils of nephridium to it.

26.—Diagram illustrating description of nephridia of same, with the various parts lettered.

REFERENCE LETTERS.

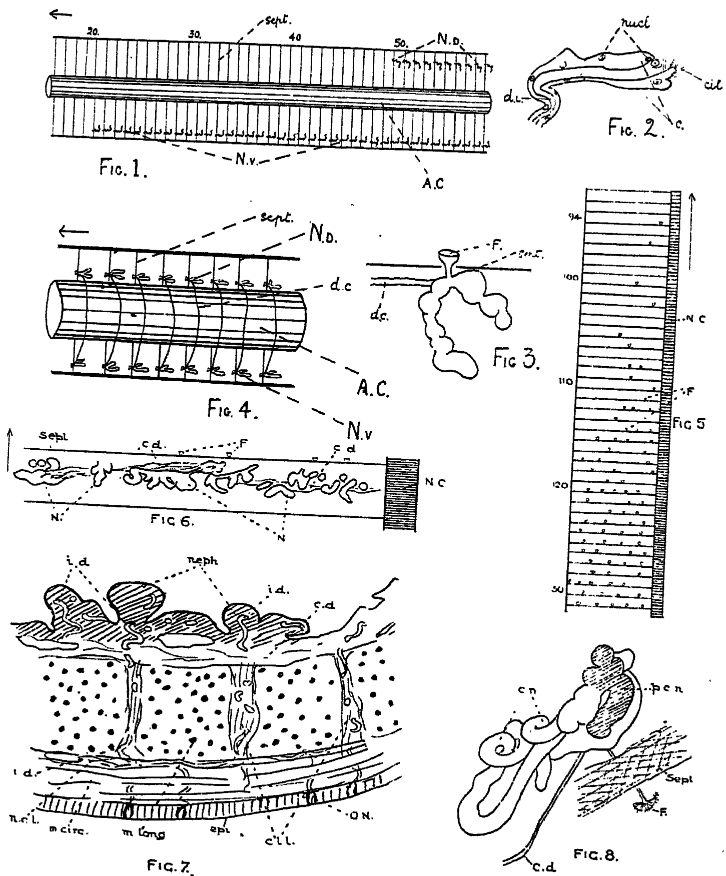
Roman numerals indicate position of setae, numbering in order from the nerve cord towards dorsal pore.

Numbers refer to numbers of segments.

Arrow points to anterior end.

A	Nephridium opening ventrally opposite 2nd seta
A. C.	Alimentary canal
B.	Nephridium opening ventrally opposite 4th seta
c.	Cells forming funnel
c. c.	Cubic cells lining entrance to intracellular duct
c. d.	Connective tissue containing ducts from meganephridia
cil.	Cilia
c m.	Marginal cells of funnel
c. n.	Nephridial coils
c. n. p.	Pigmented coil of nephridium

c. t.	Connective tissue
c. t. l.	Connective tissue between blocks of longitudinal muscle
cut.	Cuticle covering epidermis
cub. epi.	Cubic epithelial cells
d. c.	Duct connecting dorsal and ventral meganephridia
d. i.	Intracellular duct leading from the funnel
epi.	Epidermis
F.	Funnel
g. c.	Goblet cells
i. c.	Cells lining intracellular duct
i. d.	Lumen of intracellular duct
m.	Muscles
m. c.	Mass of cells round preseptal portion of intracellular duct
m. circ.	Circular muscles cut in section
m. d.	Marginal duct passing round bladder and connective tissue
m. long.	Longitudinal muscles cut in section
M. S.	Muscles forming sphincter
N.	Meganephridia
N^1.	Large nephridium with no funnel, but connected with the anterior septum
N. C.	Nerve cord
N. D.	Dorsal meganephridia
N. d.	Duct from meganephridium to sinus between longitudinal and circular muscles
N. v.	Ventral meganephridia
n., $n.^1$, $n.^2$, $n.^3$	Micronephridia
n. c. l.	Network of nephridial ducts between circular and longitudinal muscles
n^1. d.	Duct from 1st micronephridium to sinus between longitudinal and circular muscles
n^2. d.	Duct from 2nd micronephridium to sinus between longitudinal and circular muscles
$n.^3$ d.	Duct from 3rd micronephridium to sinus between longitudinal and circular muscles
neph.	Nephridia



sept.
N.D.
N.v.
A.C
Fig. 1.
nucl
cil
d.c.
c.
Fig. 2.
sept.
N.D.
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N.v
Fig. 4.
F.
d.c.
Fig 3.
N C
F
Fig 5
Sept
c.d.
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N C
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Fig 6.
i.d.
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Fig. 8.

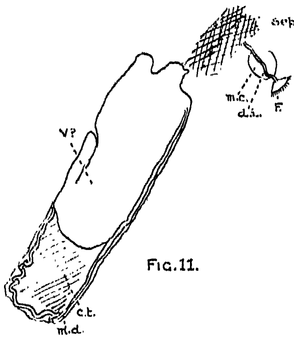

Fig. 11.

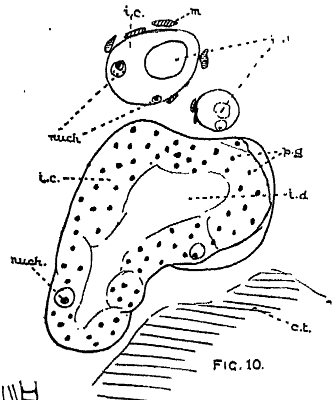

Fig. 10.

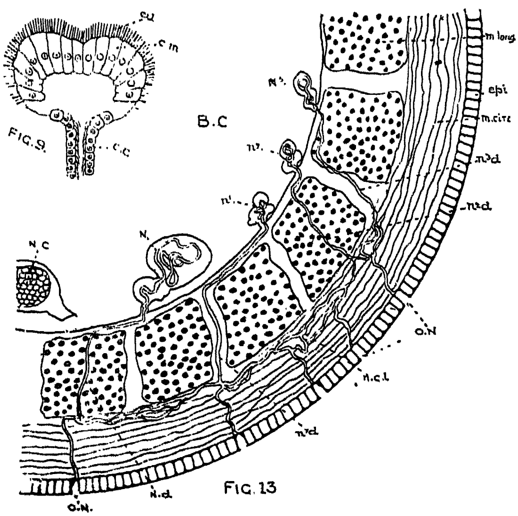

Fig. 9.

Fig 13

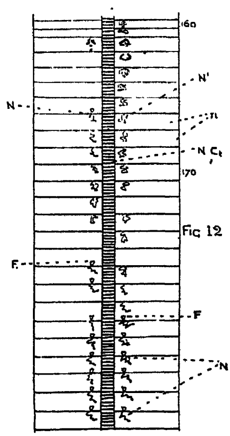

Fig 12

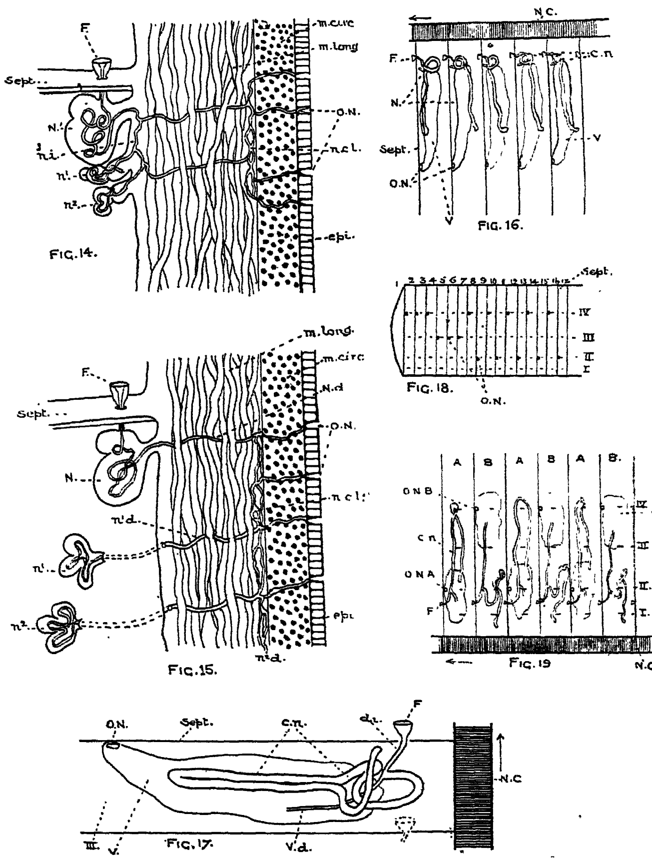
FIG. 14.
FIG. 15.
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FIG. 18.
FIG. 19

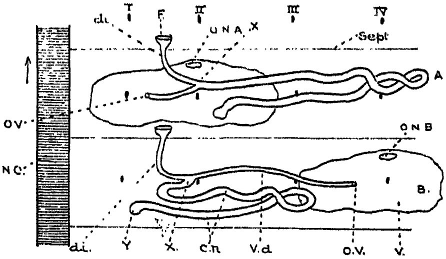

Fig. 20.

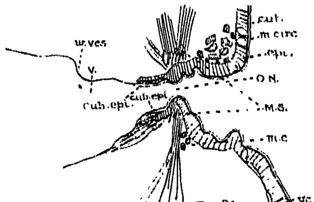

Fig 21

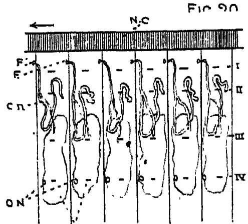

Fig. 23.

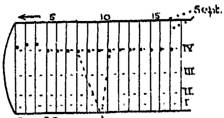

Fig. 22.

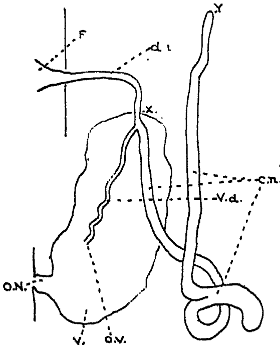

Fig. 26.

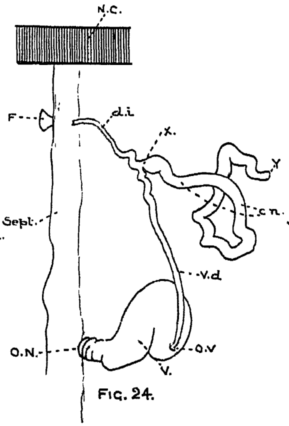

Fig. 24.

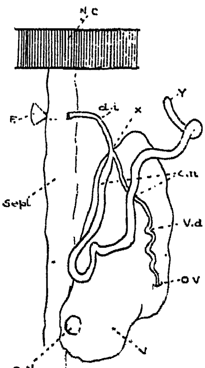

Fig. 25.

n. i.	Network of nephridial ducts before they pass through body wall
nucl.	Nuclei
O. N.	Opening of nephridium to exterior
O. N. A.	Opening of nephridium with vesicle placed ventrally
O. N. B.	Opening of nephridium with vesicle placed dorsally
o. v.	Opening of intracellular duct to vesicle
p. g.	Pigment granules
sept.	Septa joining walls of segments
V.	Vesicle
V. ?	Probable vesicle in *Diporochaeta grandis*
V. d.	Intracellular duct passing from nephridial coils (c. n.) to opening into vesicle.
w. ves.	Wall of vesicle
X.	Point where the tube from the funnel and the coiled nephridial tube are connected with with duct passing to vesicle.
Y.	Blind end of coiled nephridial tube.

[PROC. ROY. SOC. VICTORIA, 22 (N.S.), PART II., 1909].

ART. XVIII.—*Contributions to our Knowledge of Australian Earthworms.*

THE ALIMENTARY CANAL—PART I.

BY JANET W. RAFF, B.Sc.

(With Plates XLVIII.-LI.).

[Read 9th December, 1909].

The following work has been undertaken at the suggestion of Professor Spencer as a part of a general investigation into the structure of Australian earthworms now being carried on in the Biology Department of the Melbourne University.

It deals with the structure of the alimentary canal in the following species, the generic names of which are those adopted by Beddard in his "Monograph of the Order of Oligochaeta," and in Michaelsen's later work.[1]

1. *Megascolex dorsalis.*
2. *Megascolex fielderi.*
3. *Megascolex tenax.*
4. *Cryptodrilus saccarius.*
5. *Fletcherodrilus unicus.*
6. *Diporochaeta bakeri.*
7. *Diporochaeta tanjilensis.*

I have divided the work into two sections; the first dealing with the structure of the canal, and the second with special features in the different species examined.

SECTION I.

GENERAL FEATURES.

A.—*Macroscopic Structure.*

In dealing with the alimentary canal, Beddard, whose nomenclature in regard to internal anatomy I largely follow, divides it into the following parts, viz.:—(1) Mouth, (2) buccal cavity,

1 Die fauna, Südwest-Australiens," 1907. Oligochaeta.

(3) pharynx, (4) oesophagus, and (5) large intestine. The gizzard is included in the oesophagus.

From the examination of the seven species of worms above named, I find that there is a definite portion immediately following the pharynx in all of them, which, so far as I can understand, has hitherto been included in the oesophagus, as its most anterior portion. I have found, however, its structure to be so different to the remaining portion of the oesophagus that I propose to distinguish it from the other parts as a separate portion, and as it resembles in position the "crop" of European forms, I intend using this term for this particular portion. It is always present, but is hidden from view in a median dorsal dissection, owing to the pharyngeal mass extending over it, and also because of the muscles connecting the latter with the anterior portion of the gizzard.

I also intend classifying the gizzard as a distinct portion of the canal, instead of including it as part of the oesophagus.

My division of the canal will therefore be as follows:—(1) Mouth, (2) buccal cavity, (3) pharynx, (4) crop, (5) gizzard, (6) oesophagus (including the so-called calciferous glands), and (7) large intestine.

(1) The *mouth* is overhung by the prostomium.

(2) The *buccal cavity* is thin-walled, with strands of connective tissue stretching from it to the inner surface of the body wall.

(3) The *pharynx* has a large muscular mass on its dorsal surface, which is seen in a vertical dissection to be partly glandular [Fig. 1]. The internal lining is folded dorsally, sending branches far up into the mass. There are strands of muscle reaching from the posterior dorsal region of pharynx to the anterior dorsal portion of the gizzard, and also to the sides of the body, across the coelom.

(4) The *crop* is the large dilated portion in front of the gizzard, and is seen in a median vertical dissection to be thin-walled and rather large for the space it occupies, so it generally appears to be slightly folded on itself. [Fig. 1.]

(5) The *gizzard* is thick-walled and occupies one segment only, i.e., the one following that in which the crop is situated. Beddard mentions in his "Monograph of the Order of Oligochaeta" that the genus Perichaeta is remarkable for the fact

that it is provided with only a single gizzard, which nevertheless occupies two segments. He thinks it quite possible that in this case there is really a pair of gizzards which have become fused to form a single one. I have found it occupying only one segment, the exact number of which is often difficult to determine, owing to the septa at this anterior region being very thin and lying close to the canal, and to each other.

(6) The *oesophagus* is the portion between the gizzard and the intestine. It varies very much in form from the simple thin-walled tube, which may be constricted at each septum, giving the canal a pouched appearance, to the forms where the calciferous glands are present, forming in some cases large bean-shaped diverticula. We must distinguish between those portions of the oesophagus which are pouched, because of the constrictions at the septa, and those portions which are actually swollen out in the segments. The former I refer to in the description as "simple," the latter as "vascular swellings." They are easily distinguished macroscopically by their walls, the vascular swellings having a rough-looking surface owing to their inner lining being folded, and, generally speaking, being richly supplied with blood. The thin-walled, simple portions are generally in the anterior and posterior regions of the oesophagus, while the middle portion is modified in various ways.

Calciferous Glands.—The term "calciferous glands" seems to have been used in rather a loose sense, and often, where the alimentary canal of a certain worm is described as having calciferous glands, I have only been able to find vascular swellings. I have therefore restricted the term to *those swellings in the oesophagus which are not of the ordinary median kind*, i.e., *which are* NOT *simple vascular swellings. They may be sacculations of a vascular swelling* [Fig. 2], *or diverticula of the oesophagus* [Fig. 3]. It is not necessary that they should be separated from the median portion of the canal by a duct. Thus in *F. unicus* they are in the form of small pouches, varying in number in the different segments, and not separated from the median canal. It is just as if we had a large vascular swelling indented at different places, and so giving it a sacculated appearance. [Fig. 2.] So far as I have examined I find that where they are in the least separated from the canal by a constriction or a duct, they are paired.

(7) The *Large Intestine* forms the last part of the alimentary canal, reaching to the end of the body. It varies in the size of its lumen in the different specimens, but is easily distinguished from the oesophagus by its larger lumen and its lateral sacculations.

A very noticeable feature seen in the dissections of some of the species, such as *M. dorsalis, M. fielderi* and *D. tanjilensis*, is the presence of a large number of nephridial tubes attached ventrally in the region of the pharynx. They are in the form of bunches, one each side of the pharynx, and have generally been considered as "peptonephridia." The latter have been defined by Beddard as nephridia, opening into the anterior section of the alimentary canal, and functioning in relation to digestion. So far, however, as I have examined I have found them opening to the exterior, *not* into the canal. I cannot, therefore, regard them as peptonephridia, but simply as a specialized group of nephridia, the meaning of which is not clear.

B.—*Microscopic Structure.*

As regards the microscopic structure of the alimentary canal, we have much the same structure in the corresponding parts of the different species.

The presence of a cuticle is easily seen as far back as the end of the gizzard, and also in the intestine, but in the oesophageal region it is difficult to determine its existence.

I have only found cilia in certain restricted areas, viz., in the hinder portion of the oesophagus in the two species, *Megascolex dorsalis* and *Diporochaeta bakeri*, and in the calciferous glands of *Cryptodrilus saccarius*. They may be present in other regions besides these, but I have not examined enough specimens to state definitely the ciliated regions.

(1) The *mouth* leads into the buccal cavity.

(2) The *buccal cavity* is lined with a cuticle and large columnar cells. Connective tissue fibres stretch across the body space from the cavity wall to the body wall.

(3) The *pharynx* is lined by cuticularized columnar epithelium, which is folded dorsally and sends ramifications up into the dorsal mass. In sections the mass is found to consist of an

inner muscular portion forming the thick dorsal wall of the pharynx, and an outer loose glandular portion lying on the muscular mass, and continuing back so as to overlie the crop. [Fig. 1.] The mass is richly supplied with blood vessels. In examining sections it is seen that the most anterior portion of the mass is entirely muscular [Fig. 4], the middle portion has a small amount of glandular tissue dorsal to the muscle [Fig. 5], and at the hinder end it is entirely glandular [Fig. 6]. I have not found any trace of a duct in connection with this glandular mass in any of the serial sections. The cavity of the pharynx is continued up into the mass, so the gland mass may be associated with the digestive system. On the other hand there is the extra supply of nephridial tubes in this region in some cases, so the mass may be associated with the coelom.

(4) The *crop* is thin-walled, and has its lumen slightly folded. The columnar cells are large, and a thin cuticle is visible. The muscular layer is thin, and there is a fair amount of connective tissue present with blood vessels. [Fig. 7.]

(5) The *gizzard* is strongly cuticularized, and is of the ordinary structure, i.e., has a great development of circular muscle fibres, and very few transverse.

(6) The *oesophagus* is very richly supplied with blood in certain regions, and the columnar epithelium is drawn into folds to varying degrees in the different parts. In the simple portions the folds are low, and then they increase in size as the oesophagus becomes modified. The structure of a vascular swelling with long folds is represented in Fig. 8.

In the calciferous glands the lining is drawn into very long fine folds, with a very large blood supply [Figs. 2 and 3].

The muscular tissue is not very strongly developed in the oesophagael regions, but the two layers—longitudinal and circular—can generally be distinguished.

The peritoneal epithelium varies in thickness in different places. It is generally made of granulated cells of a fair size in the vascular swelling region [Fig. 8], but in the calciferous glands it is a very inconspicuous layer.

(7) The *large intestine* has the usual layers present, which, however, differ in thickness at the anterior and posterior regions respectively. At the anterior end the muscular tissue is only

slightly developed, and the peritoneal layer is large, and made of very granular cells with large nuclei. At the posterior end, the muscular tissue is more strongly developed, and the peritoneal layer is represented by a thin membrane. I have found no trace of a typhlosole in any of the specimens examined so far.

SECTION II.

DESCRIPTION OF SPECIAL FEATURES IN SPECIES EXAMINED.

As the structure of the pharynx and buccal cavity appears to be the same in all the specimens examined, except as regards the presence of special nephridia in some forms, as described above, I have not referred to those parts in the following descriptions:—

1.—**Megascolex dorsalis**, Fletcher.

Perichaeta dorsalis, Fletcher. Proc. Linn. Soc. N.S.W., vol. ii., 1887.

Plate L., Fig. 10 and Fig. 9.

(a) *Macroscopic.*—Buccal cavity and pharynx extend to end of segment 4. Crop in 5. Gizzard in 6. Oesophagus runs from segment 7-16. It is simple in 7 and 16, and dilated into vascular swellings in 8-15. Large intestine commences in 17 and is pinched in slightly at each septum. Special bunches of nephridia are situated ventrally at the sides of the pharyngeal region. The description given by Mr. Fletcher differs slightly from this.

(b) *Microscopic.*—Oesophagus in segment 7 has its lining of columnar epithelium drawn up into deep, wide folds. There is a large development of circular muscle fibres. Patches of apparently glandular tissue surround this part of the oesophagus. The structure of the oesophagus in the vascular swellings varies in the different segments. In the first two or three the lining is folded only slightly, and the muscular tissue is reduced very much. In the following swellings the folds increase in length, the muscular tissue becomes strongly developed, and the peritoneal cells form a deep layer, until in segments 13-15 we get the structure seen in Fig. 8. In the simple portion of the

oesophagus, in segment 16, the lining resembles that in segment 7, but here there is a deep layer of peritoneal cells, and also the lining is ciliated, this being one of the restricted places in which I have found cilia [Fig. 9].

2.—Megascolex fielderi, Spencer.

Perichaeta fielderi, Spencer. P.R.S. Victoria, 1892.

Plate L., Fig. 11.

(a) *Macroscopic.*—Buccal cavity and pharynx in segments 1-3. Crop in 4. Gizzard in 5. Oesophagus in 6-16; simple in 6-10, vascular swellings in 11-14, the one in 11 being small. In 15 and 16 the canal is simple and very vascular. Large intestine begins in 17, and has a large lumen. Special bunches of nephridia are present in the pharyngeal region.

This description differs slightly from that given by Professor Spencer.

(b) *Microscopic.*—In segments 6-10 the lining is thrown into deep, wide folds, and has goblet cells very largely developed in it. The circular and longitudinal muscle fibres are well developed, and there is a large blood supply. Vascular swellings, and simple canal in segments 15 and 16, similar to *Megascolex dorsalis*, but there are no cilia.

3.—Megascolex tenax, Fletcher.

Perichaeta tenax, Fletcher. Proc. Linn. Soc. N.S.W., vol. ii., 1887.

Plate L., Fig. 12.

(a) *Macroscopic.*—Buccal cavity and pharynx in segments 1-3. Crop in 4. Gizzard in 5. Oesophagus in 6-15; simple in 6-10 and 14-15, calciferous glands in 11, 12 and 13. The glands are paired and constricted off from the median canal by very short ducts. Large intestine begins in 16, the first portion in segments 16-24 being sacculated as usual, but beyond segment 24 there is a constriction in the middle of each sacculation.

(b) *Microscopic.*—Oesophagus in the simple portion has a narrow lumen, with small folds in the lining. The columnar

epithelium consists of short and long cells, alternating in groups. The muscle layers are distinct, and a fair blood supply. Calciferous glands are connected to the median canal by short ducts. The lining of the glandular portion is drawn into long thin folds, as in *Cryptodrilus saccarius.* (See below.) The muscular tissue is well developed, and there is a flat peritoneal membrane.

4.—**Cryptodrilus saccarius,** Fletcher. Proc. Linn. Soc. N.S.W., 1886.

Plate LI., Figs. 13, 17 and 18.

(a) *Macroscopic.*—Buccal cavity and pharynx in segments 1-3. Crop in 4. Gizzard in 5. Oesophagus in 6-14, being simple in 6-8, and also in 14. In 9-13 get five pairs of calciferous glands, each gland being separated from the median by a distinct duct of considerable length. The glands are bean-shaped, and each has a large vessel running along its length on the dorsal surface [Fig. 17]. Large intestine begins in 15, and is constricted in each segment at the septa.

(b) *Microscopic.*—Oesophagus has the usual structure in the simple portion. Calciferous glands show very long folds of the lining extending right across the lumen, and are richly supplied with blood. The lining here was remarkable in its columnar epithelium being ciliated, the cilia being visible with the low power [Fig. 18]. In the ducts, also, cilia are present, but they are much shorter here. A large number of goblet cells are mixed with the columnar. The median portion of the oesophagus in the calciferous gland region, has columnar epithelium not drawn into long folds, and shows a cuticle.

5.—**Fletcherodrilus unicus,** Fletcher.

Cryptodrilus unicus, Fletcher. Proc. Linn. Soc. N.S.W., 1889.

Plate LI., Fig. 14, and Plate XLVIII., Fig. 2.

(a) *Macroscopic.*—Buccal cavity and pharynx in segments 1-4. Crop in 5. Gizzard in 6. Oesophagus simple in segments 7 and

8, but swollen in 9-17. There are simple vascular swellings in 9-12 and 16-17, but in 13, 14 and 15 they form calciferous glands, paired in 13 and 15, but irregular in 14 [Fig. 2]. They are not separated from the median canal by a duct, but are like large vascular swellings constricted at different places. Large intestine at its anterior end has a small lumen, and is slightly constricted at each septum. After about segment 25 it is wider, and not constricted at the septa.

(b) *Microscopic.*—Oesophagus as far as segment 12 is of the usual type. The calciferous glands have thin walls and are very vascular. There is scarcely any muscular tissue, and the peritoneal layer is flat. The lining is drawn into long thin folds. The structure of the gland in segment 14 is represented in Fig. 2.

6.—**Diporochaeta bakeri**, Fletcher.

Perichaeta bakeri, Fletcher. Proc. Linn. Soc. N.S.W., vol. ii., 1897.

Plate LI., Fig 15.

(a) *Macroscopic.*—Buccal cavity and pharynx 1-3. Crop in 4. Gizzard in 5. Oesophagus is simple in segments 6, 7 and 8, and dilated in 9-14, dilatations being largest in 12-14. It is simple in 15 and 16.

Large intestine begins in 17.

This description differs slightly from that given by Mr. Fletcher.

(b) *Microscopic.*—Resembles *M. dorsalis.* The oesophagus in segments 15 and 16 has a ciliated lining.

7.—**Diporochaeta tanjilensis**, Spencer.

Perichaeta tanjilensis, Spencer. P.R.S. Vict., 1892.

Plate LI., Fig. 16.

(a) *Macroscopic.*—Buccal cavity and pharynx in 1-3. Crop in 4. Gizzard in 5. Oesophagus in segments 6-16, being simple in 6-8 and dilated into vascular swellings in 9-16. Large intestine

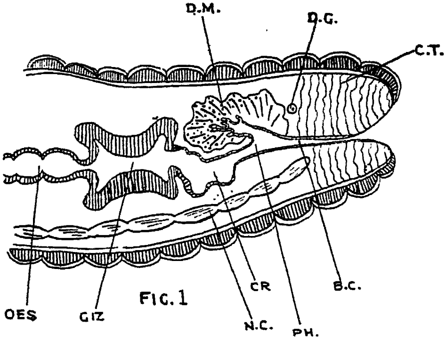

FIG. 1

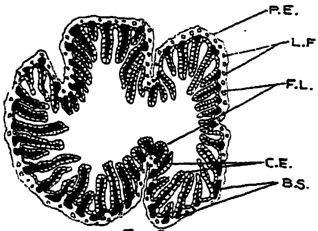

FIG. 2.

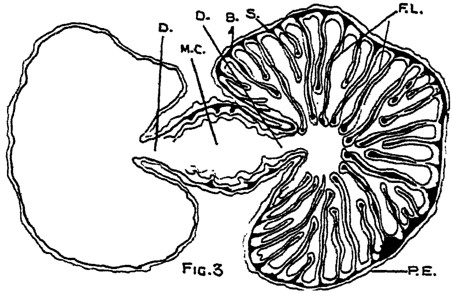

FIG. 3

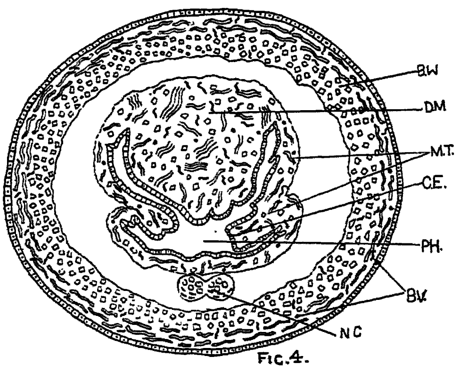

FIG. 4.

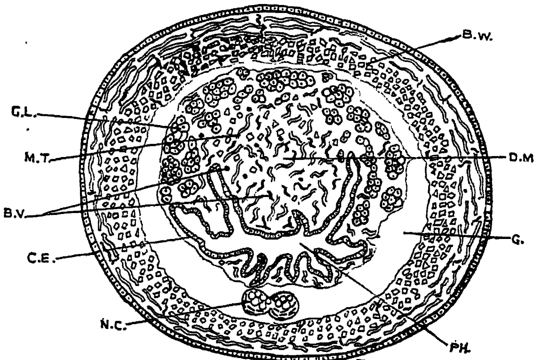

FIG. 5.

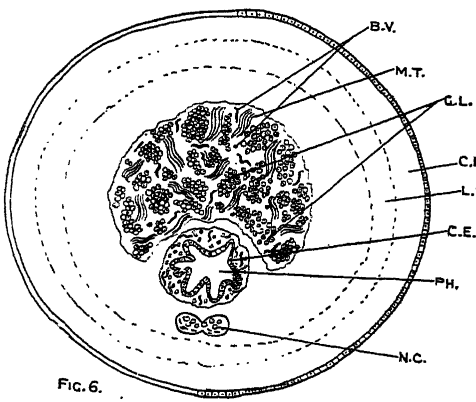

FIG. 6.

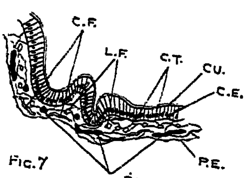

FIG. 7

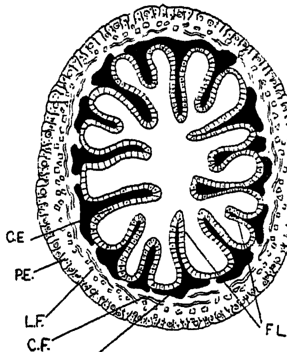

FIG. 8

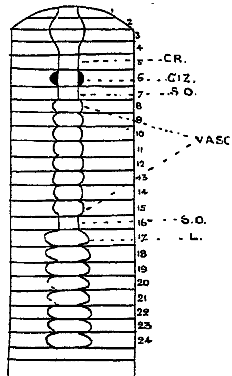

FIG 10.

MEGASCOLEX DORSALIS

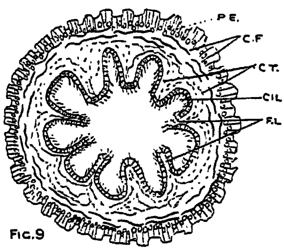

FIG. 9

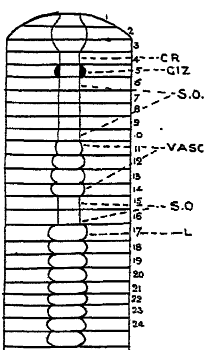

FIG. 11.

MEGASCOLEX FIELDERI

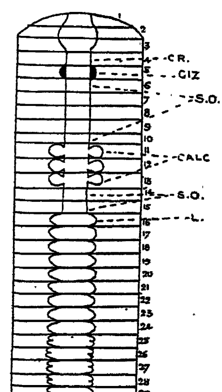

FIG. 12

MEGASCOLEX TENEX

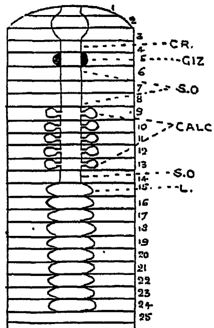

Fig. 13.
Cryptodrilus saccarius

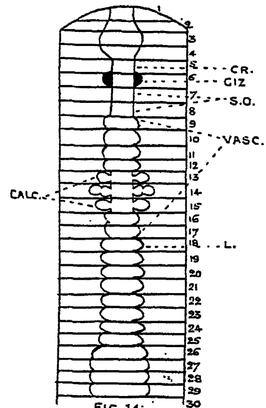

Fig. 14.
Fletcherodrilus unicus.

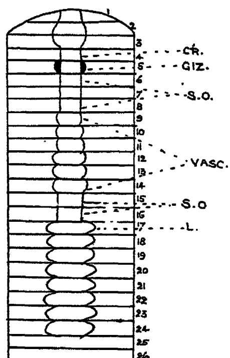

Fig. 15.
Diporochæta bakeri.

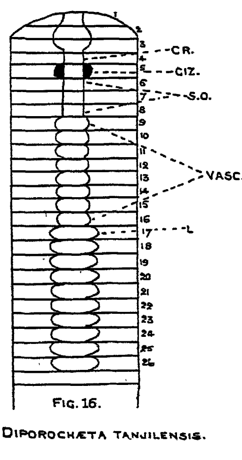

Fig. 16.
Diporochæta tanjilensis.

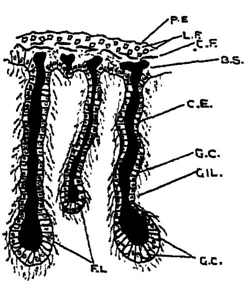

Fig. 18.

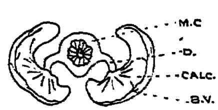

Fig. 17.

begins in 17 Special bunches of nephridia present in the pharyngeal region

(b) *Microscopic*—In the simple portion the lining is slightly folded, and has goblet cells scattered about among the columnar epithelium. There are two definite muscular layers, and the peritoneal layer is composed of granulated cells with large nuclei. Of the vascular swellings, the most anterior have low folds in the lining, which increase in length in the following segments, until, in the most posterior swellings, the structure is similar to the typical vascular swelling represented in Fig 8

EXPLANATION OF PLATES XLVIII-LI

Longitudinal vertical dissection showing typical position of pharyngeal mass and crop.

Transverse section of calciferous glands of *Fletcherodrilus unicus* in segment 14.

Transverse section of calciferous glands of *Cryptodrilus saccarius*, showing the two diverticula separated from median canal by ducts.

Transverse section of typical pharynx, through anterior portion of dorsal mass

5.—Transverse section of typical pharynx through median portion of dorsal mass, showing small amount of glandular tissue.

6.—Transverse section of typical pharynx through posterior portion of dorsal mass, showing glandular mass.

7.—High power view showing typical structure of crop.

8.—Transverse section across a vascular swelling, with long folds of lining and large blood supply.

9.—Transverse section of oesophagus in segment 16 of *M. dorsalis*, showing ciliated lining.

10-16.—Dorsal views of alimentary canal of *M. dorsalis*, *M. fielderi*, *M. tenax*, *C. saccarius*, *F. unicus*, *D. bakeri*, and *D. [illegible]*.

17.—Pair of calciferous glands of *C. saccarius* (median canal cut open).

18.—High power view of section showing structure of wall of calciferous gland of *C. saccarius*.

REFERENCE LETTERS.

B. C.	Buccal cavity
B. S.	Blood sinus
B. V.	Blood vessel
B. W.	Body wall
C.	Coelom
CALC.	Calciferous glands
C. E.	Columnar epithelium
C. F.	Circular muscle fibres
CIL.	Cilia
CR.	Crop
C. T.	Connective tissue
CU.	Cuticle
D.	Duct of gland
D. G.	Dorsal ganglion
D. M.	Dorsal mass
F. L.	Folds of lining
G. C.	Goblet cells
GIZ.	Gizzard
G. L.	Glandular tissue
L.	Large intestine
L. F.	Longitudinal muscle fibres
M. C.	Median canal
M. T.	Muscular tissue
N. C.	Nerve cord
OES.	Oesophagus
P.E.	Peritoneal epithelium
PH.	Pharynx
S. O.	Simple portion of oesophagus

[PROC. ROY. SOC. VICTORIA, 22 (N.S.), PT. II., 1909.]

ART. XIX.—*On the Bacchus Marsh Sandstones and their Fossils.*

BY G. B. PRITCHARD, B.Sc., F.G.S.,

Lecturer in Geology, etc., Working Men's College, Melbourne.

[Read 9th December, 1909.]

The Bacchus Marsh Sandstones are perhaps as well known as any series of rocks in the State of Victoria, not only to Australians, but to geologists generally in other parts of the world. This no doubt is due to the many diverse points of interest which have from time to time been connected with these deposits, and many who are not geologists are familiar with the name from different standpoints. In the first place, we may notice that this stone was opened up and quarried to a considerable extent for the purpose of a building stone. Somewhere about the years 1845 to 1847 the possibilities of this stone as a building stone were first considered, and local use was made of it for several years. Then a Government reward for a building stone within a reasonable distance for certain public buildings in Melbourne, led to a much more extensive quarry being opened, and stone was supplied for the following: —The Treasury, the old Custom House, the Crown Lands Selection Office, the Parliament House Library, and several others.

The stone was not easily obtained, as the over-burden of weathered material was regarded as too great, the jointing was not of a too favourable character, and the deeper excavations failed to yield a stone of uniform colour; in fact, the colour variations, such as concretionary banding, ultimately proved too much for the Melbourne architects.

In the light of our present knowledge it seems remarkable that such a stone should ever have been recommended, for in many respects evidence is not lacking to prove unsuitability. The association of a peculiar conglomerate with these sandstones was early recognised by Mr. A. R. C. Selwyn, as probably point-

ing to glacial conditions, though he clearly states that he found no glacially marked stones. To quote his own remarks, we may refer to the following paragraph[1]:—

"The character of the conglomerate beds before mentioned near Darley, and on the Wild Duck Creek, is such as almost to preclude the supposition of their being due to purely aqueous transport and deposition. It is, however, very suggestive of the results likely to be produced by marine glacial transport; and the mixture of coarse and fine, angular and waterworn, material, much of which has clearly been derived from distant sources, would also favour this supposition. Grooved or ice-scratched pebbles or rock-fragments have, however, not yet been observed."

Since that time innumerable glaciated stones of all sorts and sizes have been gathered by many different geologists and their mode of origin proved up to the hilt.

For information in this direction various papers by Messrs. Sweet and Brittlebank, Officer and Balfour, Dunn, David, and others, may be consulted.

This glacial material has become important from an economic point of view, for in the course of ages much of it has been cut out by river action, and as a consequence, washed, bleached and sorted into something like regular sizes. Thus on the flanks of Bald Hill, Darley, we can see fine white clay beds, white sandy clays, grits and coarse gravels mainly composed of the more durable materials such as quartz, jasper and quartzite.

On this deposit a very important industry has arisen in the manufacture of fire-bricks, fire-tiles, retorts, and many other things; and this work has been carried out in such a thorough and painstaking manner that the results are most excellent and satisfactory. The Darley Fire-Brick Company has gone ahead by leaps and bounds solely on the quality of the articles produced by them, and the care and attention exercised in their production. No doubt this will be a permanent undertaking of high commercial value to the State generally.

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1 Selwyn: Exhibition Essays, 1866. Phys. Geol. and Geol. of Victoria, p. 16.

THE FOSSIL FLORA.

1.—1847. Cyclopteris (?) angustifolia, McCoy. A.M.N.H., vol. XX., p. 148, pl. 19, f. 3, 3a.

2.—1861. Gangamopteris angustifolia, McCoy Trans. Roy. Soc. Vic., 1860, vol, V., p. 107, and footnote.

3.—1866. Gangamopteris angustifolius, McCoy. Rec. Zool. and Pal. Vic., Exhib. Essay, p. 21.

4.—1875. Gangamopteris angustifolia, McCoy. Prod. Pal. Vic., Dec. II., pp. 11-12, plates 12, (f. 1) and 13 (f. 2).
 Gangamopteris spatulata, McCoy. Id., p. 12, pl. 13, f.1, 1a.
 Gangamopteris obliqua, McCoy. Id., p. 13, pl. 12, f. 2-4.

5.—1892. Schizoneura sp. McCoy. Ann. Rep. Dept. of Mines, Vic., for 1891, p. 30.
 Zengophyllites sp. McCoy. Id.

6.—1894. Ptilophyllum officeri, McCoy. Proc. Roy. Soc. Vic., vol. VI., p. 143.

7.—1898. Taeniopteris sweeti, McCoy. Proc. Roy. Soc. Vic., vol. X., pt. 2, p. 285.

8.—1905. The Glossopteris Flora, by E. A. Newell Arber. Brit. Mus. Catalogue. Contains several references to this locality and its flora.

The first record of fossils from these sandstones was made by the late Sir Frederick McCoy as far back as 1847, which was practically contemporaneous with the opening up of the quarries in this district. In this paper, which was contributed to the Annals and Magazine of Natural History, McCoy named and figured a plant as a doubtful *Cyclopteris* under the specific name of *angustifolia*.

It was not until the year 1861 that we find the first proposal of the genus *Gangamopteris* in the Transactions of the Royal Society of Victoria, and even then it is not of a very obtrusive character.

In 1866, McCoy, in an essay on the Recent Zoology and Palaeontology of Victoria, mentions a plant from the Bacchus Marsh Sandstones, "of the size, shape, and reticulated neuration of the Glossopteris Browniana, but without the midrib," and

incidentally remarks that he had proposed the name *Gangamopteris*, and that *G. angustifolius* occurred in the New South Wales coal plant-beds with *Glossopteris browniana*.

A little more than ten years later we gain important information concerning these plants, for in 1875 McCoy published figures and descriptions of three distinct species in his Prodromus of the Palaeontology of Victoria. *G. angustifolia* is characterised by its great length and narrowness, being as much as a foot long, though usually less than one inch wide.

G. obliqua is a very wide, unequal sided, oblique form of variable size; while *G. spatulata* is a symmetrical broad-bladed knife-like form of a few inches in length.

Though these three forms were distinguished from one another and given different specific names, McCoy was fully alive to the possibility of all three belonging to the same plant, and he expresses himself very clearly on this point.[1]

On the evidence of these Gangamopterids, as interpreted by McCoy, a Mesozoic age was assigned to these beds.

Then in 1892 there was a fresh burst of enthusiasm, in view of the added interest in the discovery of numerous glaciated pebbles in the associated conglomerates, and the Annual Report for the Department of Mines of Victoria included a brief record of the occurrence of other plants, such as *Schizoneura* and *Zengophyllites*. This addition is, I think, sufficiently interesting to quote McCoy's remarks in full:—"Among the more interesting results of my investigations during the year (1891) is the recognition for the first time of, probably, Lower Triassic Rocks of the Bunter Sandstein age, in the geological series of Victoria. For this determination I have had only a few fragmentary examples filled with comminuted plant remains from a newly-discovered bed just under the famous Gangamopteris sandstone of Bacchus Marsh. These few specimens, containing small fragments of plants from below the building sandstones of Bacchus Marsh, are of the highest interest, as the only fossil remains found in any connection with the Gangamopteris sandstones. One of the plant fragments seems clearly to indicate a *Schizoneura*, and if this identification be borne out by additional specimens, which should be procured, the indication

1 Prod. Pal. Vic., Dec. ii., p. 12.

will be the addition to the geological map of Victoria of the Lower Trias formation, or Bunter Sandstein, or Grés Biggarré, leaving my old impression that the Gangamopteris beds were Upper Trias or Keuper, as corroborated by the first relative evidence. The other fragments seem referable to the *Zeugophyllites*, and would indicate in my opinion a slightly newer date."

The next item worthy of notice is in 1894, when McCoy adds *Ptilophyllum officeri* in the Proceedings of the Royal Society of Victoria, in a very brief note as an appendage to a paper by Messrs. Officer and Balfour entitled, "Further Note on the Glacial Deposits of Bacchus Marsh." The meagreness of this description, its out-of-the-way inclusion in another paper, and the absence of any illustration, will all tend to increase the difficulty of recognition of this species, even if we accept the generic location as correct.

Four years later, 1898, we have a specially interesting record in the Proceedings of the Royal Society of Victoria, by the same author, firstly, in the addition of a new species, *Taeniopteris sweeti*, and secondly that it was the closing episode to a great career. Early in the year following the publication of this paper Sir Frederick McCoy died, and no greater testimony to his wonderful vitality and interest in his work up to the last moment could be given than by noting his attitude in this, his last paper. He regarded this occurrence of Taeniopteris as a further confirmation of his belief in the Mesozoic age of the rocks.

Although we may not accept all his opinions, still we must recognise our indebtedness to him for the information we have on this highly interesting flora.

The strange way in which credit may be very easily perverted by the fallacy of reference is well illustrated in connection with a remark of Mr. E. A. Newell Arber[1], in his work on the Glossopteris Flora, published in 1905. He says: "The first mention of the latter (Gangamopteris) genus was apparently that by Selwyn in 1866, who identified it from the Bacchus Marsh Beds." Yet McCoy mentions it at the same

1 B. M. Cat., Glossopteris Flora, 1905, p. lvi.

date, and the recognition of his genus dates from 1861, even on Mr. Arber's own showing on p. 102.

The next point that calls for comment on Mr. Arber's work is that in his historical sketch[1] he accepts *G. angustifolia*, McCoy, as a good species, but relegates both *G. spatulata* and *G. obliqua* to the synonymy of *G. cyclopteroides*, Feistmantel, a well known Indian species.

Later,[2] when dealing with the flora, he remarks, "I regard McCoy's G. obliqua, and possibly also G. spatulata, as identical with the Indian fronds included here under this species. If this be the case, one of his specific names should, strictly speaking, have priority over Feistmantel's G. cyclopteroides, but the latter term has become so widely known that I have hesitated to make any change."

It is therefore obvious that there is no legitimate reason why McCoy's specific name should not be recognised according to the ordinary rules of priority. McCoy's two species may refer to the same plant, but in the absence of any direct evidence of that fact, it is most convenient to retain both names, and *G. obliqua*, McCoy, should replace *G. cyclopteroides*, Feistmantel. In the event of *G. spatulata* and *G. obliqua* being satisfactorily proved to be the same thing, even then *G. spatulata*, McCoy, is the name that should be upheld as against Feistmantel's species.

A further remark of Mr. Arber's on the Victorian Flora[3] requires some modification—"In 1878 and 1890, Feistmantel described the above species without any further additions to the flora except Phyllotheca australis, Brong., from Cape Paterson, Victoria." This evidently implies that the Cape Paterson beds belong to the same general horizon as the Bacchus Marsh beds, and that they represent the Glossopteris Flora Period. Feistmantel apparently obtained this record from a Victorian Progress Report, and no question has been raised as to the validity of the identification in the first place; but locally the Cape Paterson beds are regarded as an essential part of the Jurassic Coal Measures, and their flora as a whole is distinctly younger than the Glossopteris Flora.

1 Id.
2 Id., p. 106.
3 Id., p. lvi.

I have now a very important addition to make to the Bacchus Marsh Sandstone Flora in the genus *Calamites*, and this record is a strikingly strong confirmation of the correctness of placing these beds on the Permo-Carboniferous horizon, and of referring its fossil plant remains to the Glossopteris Flora. During November last I had a party of students at Bacchus Marsh for field geological work, and during our investigations in the lower Gangamopteris quarry overlooking the Korkuperrimal Valley, one of my assistants, Mr. Stanley Mitchell, drew my attention to a plant impression on a large block of stone, and on this being opened out, several points of interest presented themselves. The most likely portions for study were carefully wrapped up and considered later. I then found that some portions had been left behind, which might possibly throw further light on the specimen as a whole. Accordingly, accompanied by Mr. V. R. McNab, I paid another visit to the locality, and we were fortunate enough to secure the missing parts, and to open up several other similar impressions.

CALAMITES MACNABI, sp. nov.

In this preliminary note I desire to name as above, certain stem impressions, and stem impressions with lateral branches, the latter being charged with narrow linear leaf impressions.

The first specimen is on a slab about 18 inches broad by 8 inches high, and shows a broad flattened stem impression of 6 inches width, showing two nodal regions and a portion of a third, and these regions are placed approximately 3 inches apart. From the two well-defined nodal regions, two side branches are given off, each about one inch wide. Adjoining these branches are the leaf impressions, apparently carried on a thin, sheath-like envelope. There are about 3 or 4 leaf impressions in the inch width, but instead of showing a regular annular arrangement they appear to be in oblique series. On these branches the leaf impressions are about three-quarters of an inch in length, and about one-sixteenth to one-twentieth of an inch broad at the base, with a strong medial ridge.

Another specimen showing a narrower stem, about 2½ inches at the nodal region, shows a much greater distance between

the nodes, than already indicated for the larger example, in that a stem length of 8 inches only shows one nodal region.

From the same slab as the last, another leaf bearing stem of about 14 inches in length was procured. This specimen, when fully opened up, will, I think, show leaf impressions of upwards of 2 inches in length, and some additional characters may perhaps be made out.

On comparing these specimens with others, one would naturally look first to New South Wales, and in Feistmantel's fine work on the Coal and Plant-bearing Beds of Palaeozoic and Mesozoic Age of Eastern Australia and Tasmania, the record of a *Calamites* may be noted from Smith's Creek, near Stroud. This specimen is named straight out as *C. radiatus*, Brong., a well-known European species, but considering the amount of material and its evident state of preservation, there may be some room for doubt as to the correctness of this identification. Our Bacchus March specimens appear to agree fairly closely with the specimens from New South Wales, as figured by Feistmantel, Plate III., Figs. 1-3, and I should not be surprised if they ultimately proved to be the same, but for the present at any rate, I think it preferable to refer to the Bacchus Marsh specimens under a distinctive name.

[PROC. ROY. SOC. VICTORIA, 22 (N.S.), PT. II., 1909.]

ART. XX.—*A Study of the Batesford Limestone.*

BY FREDERICK CHAPMAN, A.L.S., F.R.M.S.,

Palaeontologist to the National Museum.

(With Plates LII.-LV.).

[Read 9th December, 1909.]

CONTENTS.

GENERAL DESCRIPTION.

The limestones of the Batesford area are of a twofold character. The basal portion of the series, formerly referred to as "Orbitoidal Limestone," is a true *Lepidocyclina*-rock. This rock, in its consolidated form, may be seen in the Upper Quarry, near Batesford, situated on the left bank of the Moorabool River, near the Dog Rocks, and 4¾ miles N.E. of Geelong Railway Station. The stone of this Upper Quarry is almost entirely composed of the tests of *Lepidocyclina tournoueri*, *L. marginata*, and *L. martini*. As will be shown in the sequel, the genus *Lepidocyclina* differs fundamentally from the Eocene genus *Orbitoides*, and is, elsewhere, typically Miocene, although occasionally found in the Oligocene.

The limestone of the Upper Quarry is technically known as "Moorabool Stone," and is occasionally used for building purposes. It passes upwards into a friable limestone, comparable to the polyzoal limestone of the Filter Quarries, which is overlain by a marly bed, and lastly covered by a great thickness of basalt. Dr. T. S. Hall and Mr. G. B. Pritchard[1] who have written a comprehensive account of the Tertiaries of the

1 "Notes on the Lower Tertiaries of the Southern Portion of the Moorabool Valley." Proc. Roy. Soc. Vict., vol. iv., pt. i., n.s., 1891, pp. 9-26.

Moorabool Valley, give the details of the hill-section in this locality as follows:—

"Basalt - - - - -	75 feet.
Incoherent sandy material with calcareous concretions - - - -	50 ,,
Yellow clay with calcareous concretions	5 ,,
Polyzoal limestone - - -	25 ,,
Orbitoidal limestone - - -	20 ,,
Total - - -	175 feet."

The Dryden or Filter Quarries are situated on the right bank of the Moorabool River, lower down than, and about three-quarters of a mile in a direct line from, the stone quarry. They are of much greater extent than the Moorabool Stone Quarry, the deposit being worked on a large scale by P. McCann and Sons, of Fyansford, for lime-burning, in the manufacture of cement, and for filter blocks. The Filter Quarries extend along the hill-side skirting the Moorabool, and present a section of tolerably uniform appearance. The Dripstone, for filters, is taken from the compact layers at the base of the quarries; the beds vary from 12 inches to 3 feet in thickness. The lower portion measured at one place gave 22 vertical feet of pure white to cream-coloured friable limestone, composed largely of the same foraminifera (*Lepidocyclinae*) as in the Moorabool stone, and gradually passing upwards into polyzoal rock with fewer *Lepidocyclinae.* Over this were seen 14 feet of fine-textured pale bluish clay, which closely resembles the clay of the Waurn Ponds Quarry, both as to lithological characters and microzoic contents. The deepest part of the quarry, measured by the aneroid, was 80 feet to the river.

The Moorabool Limestone is of a yellow or ochreous colour, varying to a reddish brown. The rock of this, the Upper Quarry, is fairly compact, and some portions could be selected which would take a tolerably high polish, the included foraminiferal shells adding to its ornamental appearance. More often, however, the rock is slightly cavernous, but could still be used for building purposes, for which it is eminently suitable, being an even-textured freestone. Mr. W. B. McCann, to whom I

am indebted for some valuable data regarding these quarries, informs me that the stone of the Upper Moorabool Quarry has been used in the erection (facing) of the Malvern Post Office, and the Bendigo Roman Catholic Cathedral. The crushing strength of a 3-inch cube of this stone, as ascertained by Mr. McCann, is 25 tons. The following analyses of the limestone from both quarries were made by Mr. P. G. Bayley, Assoc. S.A.S.M., and for these I am indebted to the Secretary for Mines and Mr. E. J. Dunn, F.G.S., Director of the Geological Survey.

No. 735. "Moorabool Stone." Upper Quarry. Yellowish brown, dense, tough limestone.

No. 736. Filter Quarries. White, soft, friable limestone with slight ferruginous stain.

	735.	736.
SiO_2	0.85	1.13
Al_2O_3	0.13	0.02
Fe_2O_3	1.59	0.58
FeO	0.18	0.11
MgO	0.81	1.12
CaO	53.83	54.13
CO_2	42.64	43.05
Na_2O	trace	trace
K_2O	0.06	0.05
H_2O+ (above 110° C.)	0.08	0.11
H_2O- (100° C.)	0.20	0.21
TiO_2	trace	trace
MnO	p.n.d.*	trace
CO_2	trace	trace
SO_3	nil	nil
P_2O_5	0.05	0.04
	100.42	100.55

* Under 0.10 %.
Trace indicates under 0.01 %.

The *Lepidocyclina* limestone of the Upper Quarry contains those little discoid foraminifera in great abundance, associated with a small proportion of polyzoa. When a fractured surface is examined by the aid of a lens, the tests are seen scattered

through the mass, generally with no definite arrangement, but occasionally rudely parallel. These conditions were probably induced by the ever-varying minor currents which would naturally occur in the littoral or shallow-water surroundings, most likely existing during the deposition of this rock. In the friable rock of the Filter Quarries may be frequently noticed a rough but unmistakable structure of cross-bedding, especially where the larger *Lepidocyclinae* are unusually abundant.

The microscopic structure of the compact Batesford limestone or "Moorabool Stone," as seen in thin sections, consists of a dense mass of calcareous organisms, chiefly referable to foraminifera and polyzoa. There is usually very little interstitial cement present, and what there is appears as a fine mosaic of calcite crystals. These crystals are also found lining the cavities of the small shells. Along with the encrustation of these calcareous and other grains by carbonate of lime, there has occurred an infiltration of iron oxide, with the result that the interior of the cellular bodies is often coated with it; and the structure of the fossils thereby differentiated by a thin brown deposit, which in some parts definitely crystallizes out as a mass of tiny rhombs, probably of the composition of chalybite. In this way the chambered structure of the foraminifera is, even to the naked eye, rendered distinct, upon the fractured surface of the limestone. The organisms forming the bulk of the limestone, in the order of their relative abundance, are *Lepidocyclinae*, polyzoa, *Amphisteginae*, *Rotalia calcar*, echinoid spines, calcareous algae, *Gypsinae* and *Carpenteriae*; and after these only occasional examples of the rarer foraminifera, and some ostracoda.

The fossil contents of both the friable and the compact limestones are much the same; the comparative paucity in the fossil lists from the Upper Quarry being accounted for by the unfavourable condition of the rock for the extraction of the fossils. It is probable that in some manner this consolidation of the limestone by a deposit of secondary cement is due to the proximity of the granite of the Dog Rocks. Its tenacity of structure and rough grain almost merits the English quarryman's term "ragstone."

Messrs. Hall and Pritchard, in the paper previously referred to, state that the limestone beds show a slight dip to the S.E.

From its proximity to the granite of the Dog Rocks, it is probable that this series immediately overlies it. Indeed, the evidence given me by Mr. McCann strongly points in that direction, for he says that the basal portion of the limestone is rendered so impure and "clinkery" by the included fragments of granite as to be useless for calcining.

As Messrs. Hall and Pritchard imply by their observations, the polyzoal rock forms a continuous series with the lower, *Lepidocyclina* limestone, since "similar foraminifera" occur "freely scattered through it, though its great bulk consists of polyzoa and spines and plates of echinoderms, together with a few lamellibranch shells." Evidence of a sudden change of the local conditions is seen in the sharp transition from polyzoal limestone to yellow clay; yet, as the above authors point out, the fossils of the former rock persist in the clay deposit for the first few feet, when they appear to be extinguished by turbid water conditions.

The only other known locality in Victoria which affords a similar instance of the occurrence of a *Lepidocyclina* limestone is Green Gully, Keilor, noticed by Messrs. Hall and Pritchard in their paper, "A Contribution to Our Knowledge of the Tertiaries in the Neighbourhood of Melbourne."[1] This limestone is of a pale yellow colour, and contains one of the two species of *Lepidocyclina* found in the Batesford limestone, as well as the characteristic *Gypsina howchini* found in that rock. The Keilor rock shows a great lithological variability, since, in close proximity, this limestone is replaced by a calcareous grit, still, however, containing the tests of *Lepidocyclina*, intermingled with echinoid spines and polyzoa. The beds at this exposure are 20 feet in thickness, and rest on the older volcanic series.

The Foraminifera and Ostracoda; Description of New Species and Notes on the more Important Forms.

The groups of the foraminifera and ostracoda have not been systematically worked out for the Batesford Limestone series; hence they are dealt with here in some detail. The list of identifications of foraminifera from these beds by Mr. Howchin

1 Proc. Roy. Soc. Vict., vol. ix., n.s., 1897, p. 211.

is included in Messrs Hall and Pritchard's paper.[1] The forms enumerated are, *Orbitoïdes*[2] *mantelli*, *Amphistegina* sp., *Operculina* sp., and *Gypsina* sp.

The shallow-water nature of this part of the fauna of the limestone is shown by the occurrence of the minuter forms of foraminifera usually inhabiting areas close to the shore-line, as *Polystomella crispa*, *Truncatulina lobatula*, *Nonionina boueana*, *Rotalia calcar*, and lastly and most important, by the comparatively large discoidal forms, *Cyclocypeus* and *Lepidocyclina*. In connection with this same group of organisms, it is of additional interest to note that several species first described by Dr. H. B. Brady from the "Challenger" collections, dredged in and peculiar to Australian waters, occur in these beds of comparatively remote age; so that these particular species have been persistently local from at least Miocene times, whilst some are also present in homotaxial beds in Europe, as the Miocene of the Vienna Basin.

Through the detailed results of Mr. Howchin's work on the foraminifera found elsewhere, we are enabled to make a general comparison with other tertiary foraminiferal faunas of southern Australia. Thus many of the smaller and commoner species recorded for the first time from these beds have previously occurred in the Balcombian series of the Lower Muddy Creek beds, and in strata of similar age in the neighbourhood of Port Phillip.

The ostracoda are nearly all of living species, and two are even now found in the Southern Ocean, off the Australian coast, viz., *Bairdia foveolata* and *B. amygdaloides*. These and other forms indicate a moderately shallow-water habitat.

FORAMINIFERA.

Fam. Miliolidae.

Miliolina oblonga, Montagu sp.

Vermiculum oblongum, Montagu, 1803, Test. Brit., p. 522, pl. XIV., Fig. 9. *Miliolina oblonga*, Mont. sp., Brady, 1884, Rep. Chall. vol. IX., p. 160, pl. V. Figs. 4*a*, *b*, Chap-

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1 Proc. Roy. Soc. Vict., vol. iv., pt. i., 1891, p. 18.

2 Referable to *Lepidocyclina* on account of the spatulate form of the median chamberlets.

man, 1907, Journ. Linn. Soc. London. Zool., vol. XXX., p. 17, pl. II., Fig. 26.

This species has been recorded from the Australian tertiaries, from the lower (Balcombian) and upper (Kalimnan) beds of Muddy Creek, by Mr. Howchin; and from Balcombe's Bay and the Altona Bay Coal-shaft (Balcombian) by the writer.

The present example, from the Filter Quarries, is a fully developed and typical form, and as such denotes a shallow-water habitat. The deeper water blue clays of the Balcombian localities noted above furnish small examples.

Miliolina vulgaris, d'Orbigny, sp.

Quinqueloculina vulgaris, d'Orbigny, 1826, Ann. Sci. Nat., vol. VII., p. 302, No. 33; *Miliolina auberiana*, d'Orb. sp., Brady, 1884, Rep. Chall. vol. IX., p. 162, pl. V., Figs. 8, 9; *M. vulgaris*, d'Orb. sp., Chapman, 1907, Journ. Linn. Soc. Lond. Zool., vol. XXX., p. 18, pl. II., Fig. 32.

The specimens are small, indicating less favourable conditions for growth than those from the blue Balcombian clays. Filter Quarries.

Miliolina polygona, d'Orbigny, sp.

Quinqueloculina polygona, d'Orbigny, 1839, Foram. Cuba, p. 198, pl. XII., Figs. 21-23; *Miliolina polygona*, d'Orb. sp., Chapman, 1907, Journ. Linn. Soc. London. Zool., vol. XXX., p. 18, pl. II. Fig. 29.

This species has been found only once previously in Australian tertiary deposits, in the Balcombian clays of Grice's Creek. Rare; Filter Quarries.

Miliolina ferussacii, d'Orbigny, sp.

Quinqueloculina ferussacii, d'Orbigny, 1826, Ann. Sci. Nat., vol. VII., p. 301, No. 18, Modèle No. 32; *Miliolina ferussacci*, d'Orb. sp., Brady, 1884, Rep. Chall., vol. IX., p. 175, pl. CXIII., Figs. 17, *a*, *b*; Chapman, 1907, Journ. Linn. Soc. Lond. Zool., vol. XXX., p. 19, pl. II., Fig 39.

A minute example of this species was found in the Filter Quarries. It has already been noted by Howchin from the Balcombian of Muddy Creek, and it is not uncommon in beds of similar age at Grice's Creek.

Fam. LITUOLIDAE.

Cyclammina complanata, Chapman.

C. complanata, Chapman, 1904, Rec. Geol. Surv. Vict., vol. I., pt. 3, p. 228, pl. XXII., Fig. 7.

This *Trochammina*-like species is a form apparently restricted to beds of Janjukian age; having been previously described from the Bird Rock Cliffs, and Brown's Creek, between the Aire and Joanna Rivers. The writer had it also from beds of similar age at Waurn Ponds. Filter Quarries; very rare.

Fam. TEXTULARIIDAE.

Textularia gibbosa, d'Orbigny.

T.. gibbosa, d' Orbigny, 1826, Ann. Sci. Nat., vol. p. 262, No. 6. Modèle, No. 28; Howchin, 1889, Trans. R. Soc. S. Aust., vol. XII., p. 6; Chapman, 1907, Journ. Linn. Soc. Lond. Zool., vol. XXX., p. 25, pl. III., Fig. 54.

This is a frequent form in Balcombian and Janjukian beds alike. Filter Quarries.

Textularia gibbosa, var. *tuberosa*, d'Orbigny.

T. tuberosa, d'Orbigny, 1826, Ann. Sci. Nat., vol. VII., p. 263, No. 26; Fornasini, 1889, Boll. Soc. Geol. Ital., vol. VI., p. 161, pl. II., Figs. 2*a*, *b*; *T. gibbosa*, var. *tuberosa*, d'Orb., Chapman, 1907, Journ. Linn. Soc. Lond. Zool., vol. XXX., p. 26, pl. IV., Fig. 76.

This variety is also common to the Balcombian and Janjukian beds of Victoria. It is restricted to tertiary strata, and is typical of the Neogene of Italy. In the recent condition it was found by Dr. H. B. Brady in the N. and S. Atlantic and the S. Pacific; at the latter locality it occurred at depths of 175 and 210 fathoms. Filter Quarries.

Textularia gramen, d'Orbigny.

T. gramen, d'Orbigny, 1846, Foram. Foss. Vienne, p. 248, pl. XV., Figs. 4-6; Howchin, 1889, Trans. R. Soc. S. Aust., vol. XII., p. 7; Chapman, 1907, Journ. Linn. Soc. Lond. Zool., vol. XXX., p. 25, pl. III., Fig. 53.

Well developed examples of this form occur in the Filter Quarries. The species has already been recorded from the Balcombian of Port Phillip and Muddy Creek.

Verneuilina ensiformis, sp. nov. (Plate II., Figs. 1*a*, *b*).

Test triangular, elongate, very slightly tapering; septa nearly flush with the surface, or slightly depressed. Surface of test slightly rough, granulate near the aboral end, but not spinous, as in *V. spinulosa*, Reuss., to which this form bears some resemblance.

Length, .517 mm.; greatest breadth, .224 mm.

Remarks.—This species is probably that referred to by Mr. Howchin[1] as *Verneuilina* sp., and he remarks (loc. cit.) that it resembles *V. spinulosa*, but for the elongate contour, the plane surfaces and absence of spines. Filter Quarries.

Bigenerina (*Siphogenerina*) *conica*, Heron-Allen and Earland.

Bigenerina conica, Heron-Allen and Earland, 1909, Journ. R. Micr. Soc., p. 329, pl. XVI.

This interesting little hyaline species has quite recently been described by the above-named authors, who give some excellent figures of the shell, and good diagrammatic drawings showing the internal structure. The species was previously described from the Paris tertiaries under Gümbel's name of *Clavulina eocaena*; and Heron-Allen and Earland have shown that it is distinct from that species and identical with their Selsey specimens. One of the chief points of interest is their discovery of the same species in washings from the polyzoal rock of the Filter Quarries, near Batesford. So far as I have found, the species is not common. I am indebted to Mr. Earland

1 Trans. Roy. Soc. S. Aust., 1889, vol. xii., p. 7.

for some beautifully preserved specimens from the Filter Quarries, found in material collected by Mr. E. J. Bradley, of South Australia.

Spiroplecta siphonifera, Brady sp. Pl. III. Fig 1.

Textularia siphonifera, Brady, 1881, Quart. Journ. Micr. Sci., vol. XXI., N.S. p. 53. Id., 1884, Rep. Chall., vol. IX., p. 362, pl. XLII., Figs. 25-29. Chapman, 1907, Journ. Linn. Soc. Lond. Zool., vol. XXX., p. 26, pl. III., Fig. 56.

In his description of the above form Dr. Brady mentions that it is "tapering and pointed at the aboral end." A close examination of the Batesford specimens shows the pointed end to be invariably flattened. Upon cutting vertical sections through the test in the plane of compression, it was seen that each commenced with a megalospheric chamber, followed by a short spiral, and that this was immediately succeeded by the normal textularian series. In a specimen examined in this section, the megalosphere has a diameter of 62u. Although formerly referred to the genus *Textularia*, this species, on account of the evidence now brought forward, should be relegated to the genus *Spiroplecta*.

As a recent form Dr. Brady records it from a few localities in the S. Pacific, and in the Gulf of Suez, at depths from 15-40 fathoms. The writer found it at Funafuti at various depths down to 150 fathoms, where it was most abundant. It appears to be confined to coral-reef areas, and consequently only found in tropical or sub-tropical waters, It has occurred in the fossil condition in the Balcombian of Port Phillip.

Common in both Quarries.

Spiroplecta sagittula, Defrance, sp.

Textularia sagittula, Defrance, 1824, Dict. Sci. Nat. vol. XXXII., p. 177; vol. LIII., p. 344; Atlas Conch., p. XIII., Fig. 5. *Spiroplecta sagittula*, Defr. sp., Wright, 1902, Irish Naturalist, vol. XI, p. 211, pl. III., Figs. *a-e*. Chapman, 1907, Journ. Linn. Soc. Lond. Zool., vol. XXX., p. 27, pl. III., Figs. 58, 59.

Typical specimens are not uncommon. They show the spiral commencement very clearly. *S. sagittula* is a common form in the Balcombian, the Janjukian and the Kalimnan series of Victoria. In the Janjukian it has been recorded from Waurn Ponds, near Geelong. In both Upper and Filter Quarries.

Spiroplecta sagittula, Defr. sp., var. *fistulosa*, Brady.

Textularia sagittula, Defr. var. *fistulosa*, Brady, 1884, Rep. Chall., vol. IX., p. 362, pl. XLII., Figs. 19-22. *Spiroplecta sagittula*, Defr. sp. var. *fistulosa*, Brady, Chapman, 1907, Journ. Linn. Soc. Lond. Zool., vol. XXX., p. 27, pl. III., Fig. 60.

Howchin records this form as rare in the Balcombian of Muddy Creek. In the Port Phillip tertiaries it was found to be nearly as common as the specific form. Very rare at Batesford, in the Filter Quarries.

Spiroplecta carinata, d'Orbigny, sp.

Textularia carinata, d'Orbigny, 1826, Ann. Sci. Nat., vol. VII., p. 263, No. 13. *Spiroplecta carinata* d'Orbigny, sp., Chapman, 1907, Journ. Linn. Soc. Lond. Zool., vol. XXX., p. 27, pl. III., Fig. 61.

This species has previously occurred in the Balcombian of Muddy Creek, and the Port Phillip tertiaries.

Very rare in the Filter Quarries.

Gaudryina rugosa, d'Orbigny.

G. rugosa, d'Orbigny, 1840, Mém. Soc. Géol. France, ser. I., vol. IV., p. 44, pl. IV., Figs. 20, 21. Chapman, 1907, Journ. Linn. Soc. Lond. Zool., vol. XXX., p. 28, pl. III. Fig. 64.

Typical, stoutly built tests rather common. It frequently occurs arrested at the triserial stage, and shows a tendency for the salient edges of the test to become slightly serrated, thus approaching *Verneuilina spinulosa*, from which it is separated, however, by the arenaceous structure of the shell.

It has occurred in the Balcombian of Muddy Creek, and the Port Phillip tertiaries. Filter Quarries.

Bulimina elegantissima, d'Orbigny.

B. elegantissima, d'Orbigny, 1839, Foram. Amér. Mérid., p. 51, pl. VII., Figs. 13, 14, Howchin, 1889, Trans. R. Soc. S. Aust., vol. XII., p. 18.

This moderately shallow-water form is also a well-known tertiary fossil. Recorded from both beds at Muddy Creek (Balcombian and Kalimnan) by Howchin. In the Filter Quarries; not uncommon.

Bulimina elegantissima, d'Orb. var. *apiculata*, Chapman.

B. elegantissima, var. *apiculata*, Chapman, 1907, Journ. Linn. Soc. Lond. Zool., vol. XXX., p. 31, pl. IV., Fig. 77.

This variety was originally described from the Balcombian clays of the Port Phillip tertiary beds.

In the Filter Quarries; equally common with the specific form.

Bolivina textilarioides, Reuss.

B. textilarioides, Reuss, 1862, Sitz. d. k. Ak. Wiss. Wien, vol. XLVI., p. 81, pl. X., Fig. 1. Chapman, 1907, Journ. Linn. Soc. Lond. Zool., vol. XXX., p. 31, pl. IV., Fig. 79.

A moderately deep-water form. It has occurred in the Port Phillip tertiaries (Balcombian). Very rare; in the Filter Quarries.

Bolivina punctata, d'Obigny.

B. punctata, d'Orbigny, 1839, Foram. Amér. Mérid., p. 61, pl. VIII., Figs. 10-12. Chapman, 1907, Journ. Linn. Soc. Lond. Zool., vol. XXX., p. 32, pl. IV., Fig. 80.

Common in the Balcombian clays of Muddy Creek, Grice's Creek, and of the Altona Bay Coal-shaft.

Very rare; in the Filter Quarries.

Bolivina limbata, Brady.

B. limbata, Brady, 1884, Rep. Chall. vol. IX., p. 419, pl. LII., Figs. 26-28. Chapman, 1907, Journ. Linn. Soc. Lond. Zool., vol. XXX., p. 32, pl. IV., Fig. 83.

This species has been found in the Victorian tertiaries in the Balcombian of Muddy Creek and Balcombe's Bay.

Occasional specimens met with; Filter Quarries.

Cassidulina laevigata, d'Orbigny (dentate var.).

C. laevigata, d'Orbigny, 1826, Ann. Sci. Nat., vol. VII., p. 282, pl. XV., Figs. 4, 5; Modèle, No. 41. Howchin, 1889, Trans. R. Soc. S. Aust., vol. XII. p. 8.

Previously recorded in the Victorian tertiaries from the Balcombian of Muddy Creek.

A single example of this cosmopolitan species was met with in the Filter Quarries, having the dentate periphery occasionally observed in this form.

Cassidulina calabra, Seguenza sp.

Burseolina calabra, Seguenza, 1879, Formaz. Terz. Reggio, p. 138, pl. XIII., Figs. 7*a*, *b*. *Cassidulina calabra*, Seg. sp., Brady, 1884, Rep. Chall. vol. IX., p. 431, pl. CXIII., Figs. 8*a-c*.

The original specimens were described from the Miocene of Calabria. As a recent form it has occurred at Raine's Islet, Torres Strait, and off Kandavu, Fiji Ids. This is its first occurrence as a tertiary fossil in Australia.

A typical specimen was found at Batesford, in the Filter Quarries.

Cassidulina subglobosa, Brady.

C. subglobosa, Brady, 1884, Rep. Chall. vol. IX., p. 430, pl. LIV., Figs. 17*a-c*. Chapman, 1907, Journ. Linn. Soc. Lond. Zool., vol. XXX., p. 33, pl. IV., Fig. 84.

This form is distinguished from the preceding by the inflated character of the segments and the open-pyriform shape of the aperture.

Very rare in the Filter Quarries.

Ehrenbergina serrata, Reuss.

E. serrata, Reuss, 1849, Denkschr, d. k. Ak, Wiss. Wien, vol. I., p. 377, pl. XLVIII., Figs, 7 *a-c*. Chapman, 1907, Journ. Linn. Soc. Lond. Zool., vol. XXX., p. 33, pl. IV., Figs. 85-87.

Recorded previously from the Balcombian series of Muddy Creek and the Port Phillip tertiaries.

Rare in the Filter Quarries.

Fam. LAGENIDAE.

Lagena globosa, Montagu sp.

Vermiculum globosum, Montagu, 1803, Test. Brit. p. 523, *Lagena globosa*, Montagu sp., Brady, 1884, Rep. Chall., vol. IX., p. 452, pl. LVI., Figs. 1-3.

Previously recorded from the Balcombian beds of Muddy Creek by Howchin. A single example with a subglobular test and asperous aperture was found in the limestone of the Filter Quarries.

Lagena favosopunctata, Brady.

L. favosopunctata, Brady, 1881, Quart. Journ. Micr. Sci., vol. XXI., N.S. p. 62. Idem, 1884, Rep. Chall., vol. IX., p. 473, pl. LVIII., Fig. 35; pl. LIX., Fig. 4; pl. LXI., Fig. 2.

This ornate species is extremely rare. In the recent condition it was recorded by Brady from two localities only—viz., Torres Strait, at 155 fathoms, and from the north coast of New Guinea at 17 fathoms. This appears to be its first occurrence in the fossil state.

One specimen, of a globose form, from the Filter Quarries.

Lagena orbignyana, Seguenza sp., var. *clathrata*, Brady.

Lagena clathrata, Brady, 1884, Rep. Chall., vol. IX, p. 485, pl. LX., Fig. 4. *L. orbignyana*, Seg. sp., var. *clathrata*, Brady, Millett, 1901, Journ. R. Micr. Soc., p. 628, pl. XIV., Fig. 23.

As a fossil this species is new to the Australian region. In the recent condition it has been recorded from Galway (Balkwill and Millett); from New Guinea, off the Ki Ids., and off Aru Id. (Brady); from the Malay Archipelago (Millett); and from the S. of New Zealand (Chapman Ms.).

A single specimen occurred in the Filter Quarries.

Nodosaria (Dentalina) pauperata, d'Orbigny sp.

Dentalina pauperata, d'Orbigny, 1846, Foram. Foss. Vienne, p. 46, pl. I., Figs. 57, 58.

Recorded by Howchin from both Balcombian and Kalimnan beds at Muddy Creek. One example from the Filter Quarries.

Nodosaria (Dentalina) consobrina, d'Orbigny sp.

Dentalina consobrina, d'Orbigny, 1846, Foram, Foss. Vienne, p. 46, pl. II., Figs. 1-3.

This species has been recorded previously only from the Kalimnan beds of Victoria, at Muddy Creek, by Mr. Howchin.

Not uncommon in the Filter Quarries.

Nodosaria (Dentalina) soluta, Reuss sp.

Dentalina soluta, Reuss, 1851, Zeitschr, d. deutsch, Gellsch., vol. III., p. 60, pl. III., Figs. 4*a*, *b*.

A fragmentary specimen found. This species is noted by Howchin from the Balcombian of Muddy Creek. It is a common form in the Port Phillip tertiaries of the same age, and I have also found it less frequently in Janjukian beds at Torquay, and in the Kalimnan at Jemmy's Point (T. S. Hall coll.). Filter Quarries.

Nodosaria (Dentalina) obliqua, Linné sp.

Nautilus obliquus, Linné, 1767, Syst. Nat., 12th. ed., p. 1163, 281;-1788. Ibid. 13th. (Gmelin's) ed., p. 3372, No. 14.

This species is not at all rare at Batesford. The specimens are shorter and stouter than those dredged off the coast of New Zealand, near Gt. Barrier Id. Filter Quarries.

Nodosaria scalaris, Batsch sp.

Nautilus (Orthoceras) scalaris, Batsch, 1791, Conchyl, des Seesandes, No. 4, pl. II. Figs. 4*a*, *b*. *Nodosaria scalaris*, Batsch sp., Brady, 1884, Rep. Chall., vol. IX., p. 510, pl. LXIII. Figs. 28-31.

As a recent form this species is usually found in shallow water. It is also well known as a tertiary fossil.

One example from the Filter Quarries.

Nodosaria badenensis, d'Orbigny.

N. badenensis, d'Orbigny, 1846, Foram. Foss. Vienne, p. 38, pl. I., Figs. 34, 35.

This is a short, stout form allied to the better known *N. raphanus*. It is typical of the Vienna Basin fauna, and occurs throughout the greater part of our Victorian tertiary strata.

One typical specimen from the Lepidocyclina rock of the Filter Quarries.

Cristellaria crepidula, Fitchtel and Moll sp.

Nautilus crepidulus, Fichtel and Moll, 1798, Test. Micr., p. 107, pl. XIX. Figs. G-I.

Good typical examples of this variable form were found in the *Lepidocyclina* rock of the Filter Quarries.

Cristellaria crepidula, F. and M. sp., var. *arcuata*, d'Orbigny.

Cristellaria arcuata, d'Orbigny, 1846, Foram. Foss. Vienne, p. 87, pl. III. Figs. 34-36.

A specimen was found in the limestone of the Filter Quarries, which closely matches the above variety described by d'Orbigny from the Miocene of the Vienna Basin. It represents the broad curved form which centres round *C. crepidula* as the type, and which is more elongate.

Cristellaria crepidula, F. and M. sp., var. *gladius*, Philippi var.

Marginulina gladius, Philippi, 1843, Tertiär nordwest. Deutsch., p. 40, pl. I. Fig. 37. *Cristellaria crepidula*, F. and M. sp., var. *gladius*, Philippi, Burrows and Holland, 1897, Proc. Geol. Assoc., vol. XV. p. 40, pl. I., Figs. 6, 9, 16.

This is another of the many varieties of *C. crepidula*, and is distinguished by the extraordinary elongation of the test. It somewhat resembles *C. schloenbachi* of Reuss, but is more regular in outline and evenly curved.

Found in the Filter Quarries.

Cristellaria articulata, Reuss sp.

Robulina articulata, Reuss, 1863, Sitz. d. k. Ak. Wiss. Wien. vol. XLVIII. p. 53, pl. V., Fig. 62.

Typical specimens occur in the limestone of the Filter Quarries. This species was met with by Howchin in the Balcombian of Muddy Creek. It is rather rare as a fossil form, but is abundant in certain dredgings in New Zealand waters and elsewhere.

Cristellaria rotulata, Lamarck sp.

Lenticulites rotulata, Lamarck, 1804, Annales du Muséum. vol. V., p. 188, No. 3. Tableau Encycl. et. Méth. pl. CCCCLXVI., Fig. 5. *Cristellaria rotulata*, Lam. sp., Brady, 1884, Rep. Chall., vol. IX., p. 547, pl. LXIX. Figs. 13*a*, *b*.

A few examples of this common species were found in the limestone of the Filter Quarries. Howchin records it from the Balcombian of Muddy Creek.

Polymorphina gibba, d'Orbigny.

P. (*Globulina*) *gibba*, d'Orbigny, 1826, Ann. Sci. Nat., vol. VII., p. 266, No. 20; Modèle, No. 63. *Globulina gibba*, d'Orb., 1846, Foram. Foss. Vienne, p. 227, pl. XIII., Figs. 13, 14.

Recorded by Howchin from the Kalimnan and Balcombian of Muddy Creek; and from the Kent Town Bore, Adelaide (Barwonian).

Rare in the limestone of the Filter Quarries.

Polymorphina compressa, d'Orbigny.

P. compressa, d'Orbigny, 1846, Foram. Foss. Vienna, p. 233, pl. XII., Figs, 32-34. *P. lactea*, var. *oblonga*, Williamson, 1858, Rec. Foram. Gt. Brit., p. 71, pl. VI., Fig. 149, 149*a*.

A variety with a granulose surface occurs in the limestone of the Filter Quarries. Howchin records this species from the upper beds of Muddy Creek (Kalimnan).

Polymorphina oblonga, d'Orbigny.

P. oblonga, d'Orbigny, 1846, Foram. Foss. Vienne, p. 232, pl. XII., Figs, 29-31.

Recorded by Howchin from both series at Muddy Creek. Not uncommon in the Filter Quarries.

Polymorphina elegantissima, Parker and Jones.

P. elegantissima, Parker and Jones, 1864, Phil. Trans., vol. CLV., Table X., p. 438, Brady and Jones, 1870, Linn. Soc. Lond., vol. XXVII., p. 231, pl. XL., Fig. 15. H. B. Brady, 1884, Rep. Chall., vol. IX., p. 566, pl. LXII., Figs. 12-15. Chapman, 1907, Journ. Quekett Micr. Club, p. 132, pl. X., Fig. 3.

This species is a common form in the Victorian tertiaries, and has been recorded by Howchin from both series of strata at Muddy Creek. The examples from the *Lepidocyclina* rock of the Filter Quarries at Batesford show a wide range of variation, from the broad, triangular form to the slender, elongate variety; and all showing the vertically elongated and sickle-ended segments typical of this species. As a living form it is remarkable for its peculiarly Australian distribution, the only exceptional localities being Raine Islet and Hong Kong Harbour. A closely related, if not identical form, is *P. problema*, var. *deltoidea*, Reuss, which occurs in the Septarian Clays (Oligocene) of Germany.

Polymorphina regina, Brady, Parker and Jones.

P. regina, B.P. and J., 1870, Trans. Linn. Soc. Lond., vol. XXVII., p. 241, pl. XII., Fig. 32.

A small, thin-shelled form of this beautiful species occurred in the Lepidocyclina rock of the Filter Quarries. Howchin records it from the Balcombian of Muddy Creek, and from the Kent Town Bore, Adelaide (Barwonian). In the recent condition Brady found it limited to shallow water in the Pacific. Egger records it from Kerguelen Id. at 57 fathoms; and Millett from comparatively shallow water in the Malay Archipelago. From Victorian waters the writer obtained it in some abundance from Altona Bay.

Uvigerina angulosa, Williamson.

U. angulosa, Williamson, 1858, Rec. Foram. Gt. Brit., p. 67, pl. V., Fig. 140. Flint, 1899, Rep. U.S. Nat. Mus., for 1897, p. 320, pl. LXVIII., Fig. 3.

A small but otherwise typical specimen found in the Filter Quarries. Howchin records it from the Barwonian of the Kent Town Bore, Adelaide.

Fam. GLOBIGERINIDAE.

Globigerina triloba, Reuss.

G. triloba, Reuss, 1849, Denkschr, Akad. Wiss. Wien, vol. I., p. 374, pl. XLVII., Fig. 11. *G. bulloides,* d'Orbigny, var. *triloba,* Reuss, Howchin, 1889, Trans. R. Soc.. S. Aust., col. XII., p. 11. *G. triloba,* Reuss, Chapman, 1907, Journ. Quekett Micr. Club, ser. 2, vol. X., p. 133.

As a tertiary form this is met with in the Balcombian beds of Muddy Creek and elsewhere in Victoria. It was found by the writer as a recent form, at Beaumaris and Torquay. It is not uncommon in the Filter Quarries, and a related shell occurs in thin sections of the *Lepidocyclina* rock of the Upper Quarry.

Sphaeroidina bulloides, d'Orbigny.

S. bulloides, d'Orbigny, 1826, Ann. Sci. Nat., vol. VII., p. 267, No. 1; Modèle, No. 65, Flint, 1899, Rep. U.S. Nat. Mus., for 1897, p. 325, pl. LXXI., Fig. 1.

This interesting little form, doubtfully pelagic, is moderately common in washings from the *Lepidocyclina* rock of the Filter Quarries. It has been recorded from the Balcombian of Muddy Creek by Mr. Howchin.

Fam. Rotaliidae.

Spirillina cf. *inaequalis*, Brady.

S. inaequalis, Brady, 1884, Rep. Chall. vol. IX., p. 631, pl. LXXXV. Figs. 8-11.

A single example was found in the rock from the Filter Quarries. It is concave on one face, and slightly convex on the other. The periphery is rounded rather than flat, as in Brady's figured examples. Otherwise it agrees in general characters with the above species. Howchin found *S. inaequalis* in the Balcombian of Muddy Creek. As a living form it seems confined to the southern hemisphere, in the region round Australia and the S. Pacific.

Discorbina orbicularis, Terquem sp.

Rosalina orbicularis, Terquem, 1876, Anim, sur la Plage de Dunkerque,, p. 75, pl. IX. Figs. 4*a*, *b*. *Discorbina orbicularis*, Terq. sp. Egger, 1893, Abhand, k. bayer, Akad. Wiss., Cl. II., vol. XVIII., p. 389, pl. XV. Figs. 16-18, 76-78.

An example of this little shallow-water form was found in the *Lepidocyclina* rock of the Filter Quarries. It is more convex on the superior face than usual. *D. orbicularis* is a well-known species in Miocene and Pliocene strata, and has also occurred in beds as old as the Lower Cretaceous in England. Howchin records it from the Balcombian of Muddy Creek.

Discorbina pileolus, d'Orbigny sp.

Valvulina pileolus, d'Orbigny, 1839, Foram. Amér. Mérid., p. 47, pl. I., Figs. 15-17. *Discorbina pileolus*, d'Orb. sp., Brady, 1884, Rep. Chall., vol. IX., p. 649, pl. LXXXIX., Figs. 2-4.

An Eocene and Miocene species in Europe. Howchin found it in only the Kalimnan beds of Muddy Creek. As a living foraminifer it affects quite shallow water.

Two specimens from the Filter Quarries; one being a double form, in plastogamic union.

Discorbina dimidiata, Parker and Jones.

D. dimidiata, Parker and Jones, 1862, in Carpenter, Parker and Jones' Introd. Study Foram., p. 201, Fig. XXXIIB. Parker and Jones, 1865, Phil. Trans., vol. CLV., pp. 385, 422, pl. XIX., Figs. 9*a-c*. Chapman, 1907, Journ. Quekett Micr. Club, ser. 2, vol. X., p. 136, pl. X., Figs. 8*a*, *b*.

It is of much interest to record this living Australian species from our older tertiary strata. The specimens are quite typical. Rare in the rock at the Filter Quarries.

Discorbina valvulata, d'Orbigny sp.

Rosalina valvulata, d'Orbigny, 1826, Ann. Sci. Nat., vol. VII., p. 271, No. 4. *Discorbina valvulata*, d'Orb., Brady, 1884, Rep. Chall., vol. IX., p. 644, pl. LXXXVII., Figs. 5-7.

As a living form this species is typical of the shallow waters of the Australian coast. The writer found it in shore sand at Torquay. Howchin records it from Post-tertiary beds at Port Adelaide. Moderately common in the limestone of the Filter Quarries.

Discorbina biconcava, Parker and Jones.

D. biconcava, Parker and Jones, 1865, Phil. Trans., vol. CLV., p. 422, pl. XIA., Figs. 10*a-c*. Brady, 1884, Rep. Chall. vol. IX., p. 653, pl. XCI., Figs. 2, 3.

The test of one of the Filter Quarry specimens is slightly hispid. Another found here is of exceptionally large size. This species is found still living on the Victorian coast.

Discorbina polystomelloides, Parker and Jones.

D. polystomelloides, P. and J., 1865, Phil. Trans. vol. CLV., p. 421, pl. XIX., Figs. 8*a-c*. Brady, 1884, Rep. Chall., vol. IX., p. 652, pl. XCI., Figs. 1*a-c*.

At the present time this species lives amongst the islands S. of New Guinea. Howchin records it from the Kalimnan and Balcombian of Muddy Creek. One specimen in the rock of the Filter Quarries.

Planorbulina larvata, Parker and Jones.

P. larvata, Parker and Jones, 1865, Phil. Trans. vol. CLV., p. 380, pl. XIX., Figs. 3*a*, *b*. Brady, 1884, Rep. Chall. vol. IX., p. 658, pl. XCII., Figs. 5, 6.

It is of interest to note that as a living species this form is only found in tropical areas, and especially in the sands of coral islands. In the fossil condition Howchin records it from the Balcombian of Muddy Creek, where it is moderately common.

This species is also fairly common at Batesford. The specimens from the limestone of the Filter Quarries are diminutive, with thin tests. Those from the *Lepidocyclina* limestone of the Upper Quarry are, as a rule, stouter, and with very conspicuous peripheral chambers.

Truncatulina refulgens, Montfort sp.

Cibicides refulgens, Montfort, 1808, Conchyl. System., vol. I., p. 122, 31^{e} genre. *Truncatulina refulgens*, Montf., sp., Brady, 1884, Rep. Chall. vol. IX., p. 659, pl. XCII., Figs. 7-9.

Somewhat rare in the foraminiferal rock of the Filter Quarries. Not previously recorded as a fossil from the Australian tertiary beds.

Truncatulina lobatula, Walker and Jacob sp.

Nautilus lobatulus, Walker and Jacob, 1798, Adams' Essays, Kanmacher's Ed., p. 642, pl. XIV., Fig. 36.

Typical specimens are not uncommon in the foraminiferal rock of the Filter Quarries. Howchin records this species from the Kalimnan, near Adelaide, and the Balcombian of Muddy Creek.

Truncatulina variabilis, d'Orbigny.

T. variabilis, d'Orbigny, 1826, Ann. Sci. Nat., vol. VII., p. 279, No. 8. Brady, 1884, Rep. Chall., vol. IX., p. 661, pl. XCIII., Figs. 6, 7.

This wild-growing modification of the preceding species is also moderately frequent in the limestone of the Filter Quarries. Howchin records it from the Balcombian of Muddy Creek.

Truncatulina tenuimargo, Brady.

T. tenuimargo, Brady, 1884, Rep. Chall. vol. IX., p. 662, pl. XCIII., Figs. 2, 3.

As a recent species this is frequently met with in Australian seas. It does not appear to have been previously noticed as a fossil form. A fine example from the Filter Quarries.

Truncatulina wuellerstorfi, Schwager sp.

Anomalina wuellerstorfi, Schwager, 1864, Novara-Exped., Geol. Theil, vol. II., p. 258, pl. VII., Figs. 105, 107.

Rare in the limestone of the Filter Quarries. In the living condition it is usually found in deep-water ooze. The original specimens of Schwager's came from the Pliocene of Kar Nikobar.

Truncatulina ungeriana, d'Orbigny sp.

Rotalina ungeriana, d'Orbigny, 1846, Foram. Foss. Vienne, p. 157, pl. VIII., Figs. 16-18. *Truncatulina ungeriana*, d'Orb. sp., Brady, 1884, Rep. Chall., vol. IX., p. 664, pl. XCIV., Figs. 9*a-c*.

A moderately common form in the limestone of the Filter Quarries. It is well distributed throughout the Victorian ter-

tiaries. It has been recorded from the Balcombian of Muddy Creek and the Barwonian of Mount Gambier, the Murray Flats and Adelaide. Also from the Kalimnan of Muddy Creek.

Truncatulina reticulata, Czjzek sp.

Rotalina reticulata, Czjzek, 1848, Haidinger's Naturw. Abhandl., vol. II., p. 145, pl. XIII., Figs, 7-9.

Occasional examples found in the Filter Quarries. Recorded from the Balcombian of Muddy Creek, the Barwonian of Mount Gambier and the Murray Flats. Also from the Kalimnan of Muddy Creek.

Anomalina ammonoides, Reuss sp.

Rotalina ammonoides, Reuss, 1845, Verstein, böhm. Kreidef., pt. 1, p. 36, pl. XIII., Fig. 66; pl. VIII., Fig. 53. *Anomalina ammonoides*, Reuss sp., Brady, 1884, Rep. Chall. vol. IX., p. 672, pl. XCIV., Fig. 2, 3.

Recorded by Howchin from both Kalimnan and Balcombian beds at Muddy Creek, and from the Adelaide Bore (Kent Town). One specimen from the Filter Quarries.

Anomalina grosserugosa, Gümbel sp.

Truncatulina grosserugosa, Gümbel, 1870, Abhandl. k. bayer, Ak. Wiss., vol. IX., p. 660, pl. II., Figs. 104*a*, *b*. *Anomalina grosserugosa*, Gümbel sp., Sherborn and Chapman, 1889, Journ. R. Micr. Soc., p. 487, pl. XI., Fig. 34.

In the living condition this form inhabits moderately deep water. A few typical examples from the Filter Quarries.

Carpenteria proteiformis, Goës,

C. balaniformis, Gray, var. *proteiformis*, Goës, 1882, K. Svenska, Vet.-Akad. Handl., vol. XIX., No. 4, p. 94, pl. VI., Figs. 208-214; Pl. VII., Figs. 215-219. *C. proteiformis*, Goës, Brady, 1884, Rep. Chall., vol. IX., p. 679, pl. XCVII., Figs. 8-14.

As a recent form this species shows a restricted range, and is apparently confined to coral seas. It occurs in the W. Indies,

and at a few localities in the Eastern Archipelago. *C. proteiformis* has been previously recorded as a fossil from the Balcombian of Muddy Creek by Mr. Howchin.

It is not uncommon both in the Filter Quarries and the Upper Quarry; the specimens met with show a wide range of variation.

Pulvinulina punctulata, d'Orb. sp.

P. punctulata, d'Orb. sp., Brady, 1884, Rep. Chall., vol. IX., p. 685, pl. CIV., Figs, 17*a-c*.

The peripheral edge of our specimen is more evenly rounded than usual. The surface is coarsely pitted, the sutures deeply marked, and the inferior surface tends to become granulate at the umbilicus, as in *Discorbina*, to which this form bears some affinity. *P. punctulata* does not seem to have been previously noticed in the Australian tertiaries, but it is known from tertiary strata in other parts of the world.

One specimen from the Filter Quarries.

Pulvinulina concentrica, Parker and Jones.

P. concentrica, Parker and Jones, 1864 (in Brady), Trans. Linn. Soc. Lond., vol. XXIV., p. 470, pl. XLVIII., Fig. 14. Parker and Jones, 1865, Phil. Trans., vol. CLV., p. 393, Brady, 1884, Rep. Chall., vol. IX., p. 686, pl. CV., Figs. 1*a-c*.

P. concentrica occurs as a fossil in the Miocene of Southern Italy. It was figured by Seguenza under the name of *Discorbina vestita*. As a recent form it was found, among other localities, off Kandavu, Fiji Ids., and off Raine Islet, Torres Strait.

Rare in the Filter Quarries.

Pulvinulina partschiana, d'Orbigny sp.

Rotalina partschiana, d'Orbigny, 1846, Foram. Foss. Vienne, p. 153, pl. VII., Figs. 28-30; pl. VIII., Figs. 1-3. *Pulvinulina partschiana*, d'Orbigny, sp., Brady, 1884, Rep. Chall., vol. IX., p. 699, pl. CV., Fig. 3.

In the living condition this form is usually found in deep water. Recorded by Howchin from the Balcombian of Muddy Creek.

Typical specimens, of fair size, are moderately common in the foraminiferal rock of the Filter Quarries.

Pulvinulina elegans, d'Orbigny sp.

Rotalia (Turbinulina) elegans, d'Orbigny, 1826, Ann. Sci. Nat., vol. VII., p. 276, No. 54.

The specimens found in the Batesford Limestone have a sharp periphery, but are otherwise typical. This form has been recorded from the Australian tertiaries, but only from the Murray Flats.

Very rare; Filter Quarries.

Pulvinulina scabricula, sp. nov. Pl. II., Figs. 2*a*, *b*.

Description.—Test trochoid; superior face moderately convex to tumid; whorls numerous; inferior face slightly convex, with sutures of last whorl well-marked; umbilicus with a callosity. Both surfaces of test finely and densely pitted; peripheral edges granulate to hispid. Greatest breadth of figured specimen, .414mm.; thickness at umbilical axis, .267mm.

Moderately common in the foraminiferal rock of the Filter Quarries.

Pulvinulina pulchella, d'Orbigny sp.

Rotalia pulchella, d'Orbigny, 1826, Ann. Sci. Nat., vol. VII., p. 274, No. 32. *Pulvinulina pulchella*, d'Orb. sp., Jones, Parker and Brady, 1866, Foram. Crag, Pal. Soc. Mon., vol. XIX. pl. II., Figs. 25-27.

This is a form like *P. elegans*, but with thickened sutures to the chambers. It has been recorded by Tenison Woods and Howchin from the Balcombian beds at Muddy Creek.

Frequent in the Filter Quarries.

Pulvinulina schreibersii, d'Obigny sp.

Rotalina schreibersii, d'Orbigny, 1846, Foram. Foss. Vienne, p. 154, pl. VIII., Figs 4-6. *Pulvinulina schreibersii*, d'Orb. sp., Brady, 1884, Rep. Chall., vol. IX., p. 697, pl. CXV., Figs 1*a-c*.

The more depressed varieties have a sharp peripheral keel. *P. schreibersii* was recorded by Howchin from the Balcombian of Muddy Creek.

Frequent in the foraminiferal rock of the Filter Quarries.

Rotalia clathrata, Brady.

Rotalia clathrata, Brady, 1884, Rep. Chall., vol. IX., p. 709, pl. CVII., Figs. 8, 9. Howchin, 1889, Trans. R. Soc. S. Aust., vol. XII., p. 15.

It interesting to note the occurrence of this species as a fossil in the Balcombian series in Victoria. At Muddy Creek Mr. Howchin found it to be moderately common; and it has also occurred in the Janjukian at several localities examined by the writer; whilst in the Kalimnan it is an exceptionally abundant form. The species seems to be restricted to a very limited area at the present day, for Brady records it only from four localities between Bass Strait (at Moncoeur Id.) and Cook Strait, New Zealand; and from two stations on the West Coast of Patagonia. These localities are practically co-extensive with the Middle Tertiary shore-line, which had so many species of mollusca in common, embracing the Santa Cruz series of Patagonia, the Oamaru series of New Zealand, and the Barwonian of Victoria. The tests of *R. clathrata* from the Janjukian are more heavily built than those from the Kalimnan and Recent deposits.

Very common in the Batesford Limestone at both Quarries.

Rotalina calcar, d'Orbigny, sp. Pl. III. Fig. 2.

Calcarina calcar, d'Orbigny, 1826, Ann. Sci. Nat., vol. VII., p. 276, No. 1; Modèle, No. 34. Id., 1839, Foram. Cuba, p. 93, pl. V., Figs. 22-24. *Rotalia calcar*, d'Orbigny sp., Brady, 1884, Rep. Chall., vol. IX., p. 709, pl. CVIII., Fig. 3.

A very striking species, and, next to the *Lepidocyclinae* and the *Amphisteginae*, the most abundant form in the Batesford Limestone. The ornament consists of numerous papillae of supplemental shell-growth, a thickened umbilicus, ridged and papillate intersutural areas on the superior face, and angular or bluntly pointed peripheral spines. The distribution of *Rotalia calcar* at the present day is wide, but confined chiefly to the coral seas.

As a fossil it is known from beds as old as the Middle Eocene. It has already been recorded, as a rare form, from the Balcombian of Muddy Creek, by Howchin.

Very abundant in the *Lepidocyclina* limestone of the Filter Quarries and the Upper Quarry.

Gypsina globulus, Reuss sp.

Ceriopora globulus, Reuss, 1847, Haidinger's Naturw. Abhandl., vol. II., p. 33, pl. V., Fig. 7. *Gypsina globulus*, Reuss sp., Brady, 1884, Rep. Chall., vol. IX., p. 717, pl. CI., Fig. 8.

Howchin records this species as a fossil from both beds at Muddy Creek; in the Balcombian it is common, and in the Kalimnan rather scarce. *G. globulus* is moderately common in the foraminiferal rock of the Filter Quarries, and the specimens are generally less than the average size.

Gypsina vesicularis, Parker and Jones sp.

Orbitolina vesicularis, Parker and Jones, 1860, Ann. and Mag. Nat. Hist., ser. 3, vol. VI., p. 31, No. 5. *Gypsina vesicularis*, Brady, 1884, Rep. Chall., vol. IX., p. 718, pl. CI., Figs. 9-12.

This and the foregoing species date their first appearance as fossils from the Miocene; being found in beds of that age in Austria, Hungary, the S. of France and the W. Indies. At the present day they are almost confined to coral seas, although

the two species are occasionally met with on the Atlantic seaboard of the British Ids.

G. vesicularis is recorded by Howchin from Muddy Creek; as being common in the Balcombian and rare in the Kalimnan. It is interesting thus to note the certain influence of climatic changes.

In the Filter Quarries, not common. Specimens rather small.

Gypsina howchini, sp. nov. Pl. II., Figs. 4*a*, *b*; pl. III., Figs. 3-5.

Description.—Test discoidal; opposite faces more or less slightly convex, rarely flat, or more rarely slightly concave. Surface granulate to pustular, as in *G. vesicularis.* Chamberlets numerous, with a sub-concentric arrangement. Shell-wall coarsely perforate. Central series of chambers globigeriniform and surrounded by a series of small chamberlets, which in turn is succeeded by the larger, normal chamberlets. No marked differentiation of the chamberlets along the median plane when examined in vertical section, except in their being more spacious in occasional specimens.

Diameter of test, 1.5 to 2.4mm.

Observations.—A reference to the genus *Gypsina* as occurring in the Upper Quarry at Batesford is made by Messrs. T. S. Hall and G. B. Pritchard in their paper on the Lower Tertiaries of the Moorabool Valley, which in all probability is the form above described. I have much pleasure in naming this species after Mr. W. Howchin, who determined the genus for the above-named authors.

G. howchini is a very distinct form in the Batesford limestone. It has the coarsely perforate structure of the chamberlets seen in *G. vesicularis*, P. and J. sp., but is invariably discoidal. Dr. Goës figured a recent variation of the latter type, from the Carribean Sea,[1] which he named *G. vesicularis*, var. *discus:* that form, however, has a differentiated median layer of chamberlets as in the Miocene genus *Miogypsina*, but without the vertical pillars, and the shell-wall is usually thinner. It is probable that the species now described is a climatal modifi-

1 Bull. Mus. Comp. Zool., Harvard Coll., vol. xxix., No. i., 1891, pl. vii., figs. 5, 4-6.

cation of the Miocene form, since both types occur in beds of the same age, characterised by the same species of Lepidocyclines, that is to say, the Miocene beds in the E. Indies contain *Lepidocyclina marginata* and *Miogypsina*,[1] whilst at Batesford the *L. marginata* is accompanied by *Gypsina howchini*. The *Miogypsinae* of the Miocene and the related *Gypsina vesicularis* var. *discus* are both typical of coral seas.

Common in the *Lepidocyclina* limestone of both Quarries.

Polytrema minutum, sp. nov. Pl. II., Figs. 3*a*, *b*.

Description.—Test very small; conical, with a spreading base. Body of test slender, and with minute branches. Chamberlets minute.

Width of base, .93 mm.; height, .517 mm.

Observations.—This is an exceeding small and neat modification of *P. miniaceum*, and may be distinguished from that form by the almost perfectly circular base, short habit and slender branches.

Two specimens from the foraminiferal rock of the Filter Quarries.

Family Nummulinidae.

Nonionina umbilicatula, Montagu sp.

Nautilus umbilicatulus, Montagu, 1803, Test. Brit., p. 191; Suppl., p. 78, pl. XVIII., Fig. 1.

Previously recorded from the Balcombian of Muddy Creek by Howchin.

One specimen in the foraminiferal rock of the Filter Quarries.

Nonionina boueana, d'Orbigny.

Nonionina boueana, d'Orbigny, 1846, Foram. Foss. Vienne, p. 108, pl. V., Figs. 11, 12.

The nearest locality where this species now lives appears to be the West Coast of Patagonia. It is a common Upper Oligocene and Miocene form. The species is new to the Australian Tertiary fauna.

A typical specimen from the Filter Quarries.

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1 Miogypsina, according to Vraldenberg, has not yet been met with in India.

Polystomella subnodosa, Münster sp.

Robulina subnodosa, Münster, 1838 (fide Roemer), Neues Jahrb, für, Min., etc., p. 391, pl. III., Fig. 61. *Polystomella subnodosa*, Münster sp., Brady, 1884, Rep. Chall. vol. IX., p. 734, pl. CX., Figs. 1*a*, *b*.

Howchin has noted this species from Muddy Creek, but only from the Upper Beds. One specimen from the Filter Quarries.

Polystomella antonina, d'Orbigny. Pl. II., Figs 5*a*, *b*.

P. antonina, d'Orbigny, 1846, Foram. Foss. Vienne, p. 128, pl. VI., Fig. 17, 18.

This species somewhat resembles *P. subnodosa*, Münst. sp., but differs in its much greater umbilical diameter, in the fewer exposed chambers, and in its coarse septal bars. It has been previously recorded only from the Miocene of the Vienna Basin.

Three examples from the Filter Quarries.

Polystomella crispa, Linné sp.

P. crispa, Linné sp., Brady, 1884, Rep. Chall. vol. IX., p. 736, pl. CX., Figs. 6, 7.

Recorded only from the later Tertiary beds by Howchin, viz., from N.W. Bend, Adelaide, and Muddy Creek (Kalimnan).

A few examples met with in the limestone of the Filter Quarries.

Polystomella verriculata, Brady.

P. verriculata, Brady, 1884, Rep. Chall., vol. IX., p. 738, pl. CX., Figs. 12*a*, *b*.

As a living form this species is practically restricted to its early Tertiary geographical position, it having been found off E. Moncoeur Id., Bass Strait, and in Curtis Strait, Queensland, by the "Challenger."

Howchin records this species as rare at Muddy Creek (Balcombian).

A few examples found in the Filter Quarries.

Amphistegina lessonii, d'Orbigny, Pl. III., Fig. 6.

A. lessonii, d'Orbigny, 1826, Ann. Sci. Nat., vol. VII., p. 304, No. 3, pl. XVII., Figs. 1-4 *A. hauerina*, Id., 1846, Foram. Foss. Vienne, p. 207, pl. XII., Figs. 3-5. *A. campbelli*, Karrer, 1864, Novara Exped., Geol. Theil, vol. I., p. 84, pl. XVI., Fig. 18. *A. aucklandica*, Id., 1864, ibid., p. 85, pl. XVI., Fig. 19. *A. lessonii*, d'Orb., Brady, 1884, Rep. Chall., vol. IX., p. 740, pl. CXI., Figs. 1-7.

The majority of specimens found in the Batesford limestone are of the compressed lenticular variety, as typified in *A. hauerina* of the Vienna Miocene, and some examples attain a fair size, often as much as 2.5mm. in diameter. They are frequently so nearly equilateral as to closely resemble the small species of Nummulites like *N. variolaria*. The resemblance, however, is only external, since a cross-section reveals the unequal umbilical cones and the one-sided alar overlap of the septal margin.

A. lessonii is very common in the upper portion of the beds, the polyzoal rock, taking the place of the *Lepidocyclinae* of the lower beds. Both Quarries.

Operculina complanata, Defrance sp.

Lenticulites complanata, Defrance, 1822, Dic. Sci. Nat., vol. XXV. p. 453. Operculina complanata, Defr. sp., Brady, 1884, Rep. Chall., vol. IX., p. 743, pl. CXII., Figs. 3, 4, 5, 8.

Occasional; in the limestone of the Filter Quarries and in the Upper Quarry.

Operculina complanata, Defr. sp., var. *granulosa*, Leymerie.

Operculina granulosa, Leymerie, 1846, Mém. Soc. Géol. France, sér. 2, vol. I., p. 359, pl. XIII., Figs. 12*a*, *b*.

Tests very finely granulate. The septa occasionally evince a tendency to bifurcate near the peripheral border, after the manner of *Heterostegina*. Frequent. In the Filter Quarries and the Upper Quarry.

Heterostegina depressa, d'Orbigny.

H. depressa, d'Orbigny, 1826, Ann. Sci. Nat., vol. VII., p. 305, pl. XVII., Figs. 5-7; Modéle, No. 99. Brady, 1884, Rep. Chall., vol. IX., p. 746, pl. CXII., Figs. 14-20.

Some of the specimens found here are papillate, and closely approach Schlumberger's *H. margaritata*,[1] from the Miocene of the Dutch E. Indies, with which species they may eventually be identified.

Rare. Found in the Filter Quarries and also in the Upper Quarry at Batesford limestone.

Cycloclypeus pustulosus, Chapman, Pl. II., Fig. 6; pl. V., Fig. 4.

C. pustulosus, Chapman, 1905, Journ. Linn. Soc. N.S.W., vol. XXX., p. 271, pl. V., Fig. 1; pl. VI., Fig. 2; pl. VII., Fig. 2.

This is a very distinct species, having the papillae of the test-surface distributed over the whole of the shell. Both the megalospheric and the microspheric forms are found here, as they are at Santo, New Hebrides, from the Miocene of which locality they were first described.

Not uncommon at Batesford, in both Quarries, in the *Lepidocyclina* rock.

Lepidocyclina tournoueri, Lemoine and Douvillé, Pl. IV. Figs. 1, 2 (part) and 6.

L. tournoueri, Lemoine and Douvillé, 1904, Mém. Soc. Géol. France, vol. XII. fasc. II., p. 19, pl. I., Fig. 5; pl. II., Figs. 2-14, Pl. III., Fig. 1. R. Douvillé, 1907, Bull. Soc. Geol. France, p. 52 et seq. and Figs. 5, 7, 13, 16, 17, 37.

This is the commonest species of the genus in the Batesford *Lepidocyclina* limestone, and the tests often compose the greater part of the rock. Found in both Quarries.

The characters of this species are as follows:—Umbilical axis salient or apiculate on each face; peripheral edge sharp; granulations coarse in centre, smaller and more numerous in the

1 Samml. Geol. Reichs.-Mus. Leiden., ser. i., vol. vi., pt. iii., 1902, p. 252, pl. vii., fig. 4.

outer area and extending to the periphery. Internally the pillars, in vertical section, are seen to be numerous and slender; in median section the megasphere is subcircular and immersed in the semi-lunar secondary chamber. Equatorial chamberlets spatuliform, rarely hexagonal. The megasphere in a Batesford specimen has a diameter of .195mm. The megasphere of the E. Indian examples of this species is exactly similar in shape to the Victorian examples, and would consequently, according to R. Douvillé, belong to the same geographical race.

L. tournoueri was first described from Mediterranean examples by MM. P. Lemoine and R. Douvillé, and it has since been recorded from Borneo by H. Douvillé in beds referred to the Burdigalian.

In the original description, the diameter of the test of this species is given as about 2mm., and our Batesford specimens have the same dimensions.

Lepidocyclina marginata, Michelotti sp. Pl. IV. Fig. 5; pl. V., Figs. 1-3.

Nummulites marginata, Michelotti, 1841, Mem. Soc. ital. del Scienze, vol. XXII., p. 45, pl. III., Fig. 4. *Orbitoides marginata*, Michelotti, 1847, Naturk. Verh. Holl. Maatsch-Wetensch, Haarlem, vol. III., p. 16, pl. I., Fig. 10. *Orbitoides mantelli*, Howchin (non Morton), 1891, in Hall and Pritchard, Proc. Roy. Soc. Vict., p. 10, et seq. *Lepidocyclina marginata*, Michelotti sp., P. Lemoine and R. Douvillé, 1904, Mém. Soc. Géol. France, vol. XII., fasc. II., p. 16, pl. I., Fig. 7; pl. II., Figs. 7, 9, 11, 20; pl. III., Figs. 3, 8, 9, 13.

The test of this species is usually comparatively large and thin; the diameter of some Batesford specimens measuring as much as 15mm. The swollen central area is distinctly granulate, whilst the thin peripheral portion has the granules much finer. In vertical section the pillars are seen to be numerous and very slender in the peripheral flange-like portion, and gradually thicken towards the region of the umbilical boss, where they protrude from the surface as distinct papillae. The equatorial chambers of this species are distinguished from those

of *L. mantelli*, to which it bears some external resemblance, by the longer sides and cuspid, not broadly arched, ends. Both megalospheric and microspheric forms (forms A and B) occur at Batesford, the former being common, the latter very rare. A megasphere in a Batesford specimen measures .319mm. in diameter. The equatorial chambers of *L. marginata* are spatuliform, and as R. Douvillé has pointed out,[1] this type is characteristic of the E. Indian race of Leptocyclines, as distinct from the American race with the hexagonal outline, including forms like *L. dilatata* and *L. canellei*.

H. Douvillé,[2] in "Les Foraminiferes dans le Tertiaire de Borneo," places the beds H (sand and clay), containing *Lepidocyclina tournoueri*, *L. sumatrensis*, *Miogypsina*, and *Operculina niasi*, in the Burdigalian stage (Middle Miocene).

E. W. Vredenburg[3] remarks that the Lepidocyclines found in the Gaj beds of India are often of large dimensions, and belong exclusively to the group of *L. marginata*, with large pillars and a megasphere only partly enveloped by the second chamber. The Gaj beds contain no large Nummulites, and Vredenburg refers to them as probably Uppermost Aquitanian (Lower Miocene).

Found in both Quarries.

Lepidocyclina martini, Schlumberger. Pl. IV., Figs. 2 (part), 3 and 4.

Orbitoides stellata, Howchin (non d'Archiac), 1889, Trans. R. Soc. S. Aust., vol. XII., p. 17; id. ibib, 1891, vol. XIV., p. 356. *Lepidocyclina martini*, Schlumberger, 1900, Samml. Geol. Reichs-Mus. Leiden, ser. I., vol. VI., pt. 3, p. 131, pl. VI., Figs. 5, 8. L. martini, Schl., Chapman, 1905, Journ. Linn. Soc. N.S.W., vol. XXX., p. 272, pl. V., Fig. 2.

This form out of the Batesford limestone is a true *Lepidocyclina*, and is clearly referable to Schlumberger's *L. martini*, which that author described from the Miocene beds of Java,

1 Bull. Soc. Geol. France, 1907, ser. iv., vol. vii., p. 57.
2 Ibid, 1905, ser. iv., vol. v., p. 454.
3 Records Geol. Surv. India, vol. xxxv., 1907, p. 67.

D'Archiac's species *stellata* has the same outline, but the chambers of the median plane are rectangular, and it is now referred to the Eocene genus *Orthophragmina.* I have already recorded *L. martini,* from the Miocene limestone of the West Coast of Santo, New Hebrides.

The test of the above species is distinguished externally by its roughly stellate form, with prominent ridges passing from the central area into the peripheral processes; the latter tend to flatten out at the extremities. A megasphere of this species from Batesford measures .172mm. in diameter. The test sometimes attains a diameter of 5mm.

Moderately common in the basal limestones of both Quarries.

OSTRACODA.

Fam. CYPRIDAE.

Pontocypris attenuata, Reuss.

P. attenuata, Reuss, G. S. Brady, 1868, Ann. Mag. Nat. Hist., ser. 4, vol. II., p. 179, pl. IV., Figs. 11-14. Id., 1880, Rep. Chall. Zool., pt. III. p. 38, pl. XV., Figs. 2*a-d*.

This species is now living in the Indian Ocean, around New Guinea, and in the China Seas.

A small but characteristic valve from the Filter Quarries.

Bythocypris reniformis, G. S. Brady.

B. reniformis, G. S. Brady, 1880, Rep. Chall. Zool., pt. III., p. 46, pl. V., Figs. 1*a-l*.

This species, as a living form, has a wide distribution. Amongst other localities it has been recorded off E. Monçoeur Id., Bass Strait, 38-40 fathoms.

A single carapace found in the limestone of the Filter Quarries.

Bairdia amygdaloides, G. S. Brady.

B. amygdaloides, G. S. Brady, 1865, Trans. Zool. Soc. Lond., vol. V., p. 364, pl. LVII., Figs. 6*a-c*. Id., 1880, Rep. Chall. Zool., pt. III., p. 54, pl. IX., Figs. 5*a-f*; pl. X. Figs. 2*a-c*.

A distinguishing feature of this species is its evenly arched carapace, as seen from above. It is found living in Bass Strait,

and in Port Jackson; and its range extends into the coral seas of the Pacific.

Abundant in the limestone of the Filter Quarries, also from the Upper Quarry.

Bairdia foveolata, G. S. Brady.

B. foveolata, G. S. Brady, 1867, les Fonds de la Mer, vol. I., p. 56, pl. VII., Figs. 4-6. Idem, 1880, Rep. Chall. Zool. pt. III., p. 55, pl. VIII., Figs 1*a-f*; Figs. 2*a-f*. Chapman, 1902, Journ. Linn. Soc. Lond. Zool., vol. XXVIII. p. 423. *B.* cf. *foveolata*, G.S.B., Id., 1905, Journ. Linn. Soc. N.S. Wales, vol. XXX., p. 272, pl. XII. Fig. 1.

This species is found living in the Atlantic and Pacific Oceans, and its range extends as far south as Bass Strait. There is not much doubt that it was this species which occurred in the Miocene limestones of Santo, New Hebrides.

The carapace of *B. foveolata*, as seen from above, is tumid in the centre, and the surface is generally distinctly pitted.

A few carapaces and detached valves were found in the limestone of the Filter Quarries.

Fam. CYTHERIDAE.

Cythere wyville-thomsoni, G. S. Brady.

C. wyville-thomsoni, G. S. Brady, 1880, Rep. Chall. Zoöl., pt. III., p. 82, pl. XX., Figs. 4*a-f*.

This species is now living in the Southern Ocean and in Torres Strait. A carapace and two separate valves from the Filter Quarries; and one carapace from the *Lepidocyclina*-limestone of the Upper Quarry.

Loxoconcha alata, G. S. Brady.

L. alata, G. S. Brady, 1868, Ann. Mag. Nat. Hist., ser. 4, vol. II., p. 223, pl. XIV., Figs. 8-13.

This species is found living at Honolulu and Mauritius, and is therefore confined to coral seas at the present day.

Two carapaces and a single valve from the Filter Quarries.

Xestoleberis curta, G. S. Brady sp.

Cytheridea (?) curta, G. S. Brady, 1865, Trans. Zool. Soc. Lond., vol. V., p. 370, pl. LVIII., Figs. 7*a*, *b*. *Xestoleberis curta*, G. S. Brady, 1880, Rep. Chall. Zool., vol. I., pt. III., p. 126, pl. XXXI., Figs. 6*a-d*.

The distribution of this species at the present day is the W. Indies, the S. Pacific and the Southern Ocean. At Port Jackson it is found at 2-10 fathoms. Our specimen is narrower than usual in side view, but it has the characteristic, truncated posterior margin.

One example from the Filter Quarries.

(?) Cytheropteron angustatum, G. S. Brady.

(?) Cytheropteron angustatum, G. S. Brady, 1880, Rep. Chall. Zool., vol. I., pt. III., p. 137, pl. XXXIV., Figs. 5*a*, *b*.

Recent examples of this form have been dredged at Balfour Bay, Kerguelen Id., at 20-50 fathoms; and at Torres Strait, 155 fathoms.

One valve from the Filter Quarries.

Cytheropteron batesfordiense, sp. nov. Plate II., Figs. 7*a-c*.

Description.—Carapace seen from the side, elongate ovate; anterior truncately rounded at the dorsal angle, posterior produced at the ventral angle, the extremity sub-spinose; anterior and ventral margins keeled; dorsal line broadly arched, ventral, sinuous. Lateral alae pronounced, long and gently curved. Carapace thickest at the middle of the ventral margin, rapidly sloping to the extremities and the dorsal border. Surface of carapace finely pitted. Edge view, ovate, compressed at the extremities. End view, sub-triangular. Height of carapace equal to about half the length; thickness of carapace more than half the length.

Length, 1mm.; height, .62mm.; thickness of, carapace, .655mm.

Affinities.—This species is quite distinct from *C. wellingtoniense*,[1] G. S. Brady, although showing some relationship in

1 Rep. Chall. Zool., vol. i., pt. iii., 1880, p. 136, pl. xxxiv., figs. 4*a-d*.

having a sub-triangular carapace, as seen from the end, and in the surface pittings. The shape in side view differs materially in that our species is broader anteriorly and narrower posteriorly, the reverse of that seen in *C. wellingtoniense.*

A carapace and two separate valves from the *Lepidocyclina*-rock of the Filter Quarries.

THE FAUNA OF THE BATESFORD LIMESTONE.

Preliminary Remarks.—The several records of species from the Batesford limestone, comprising the foraminiferal and polyzoal rocks, are here collected in systematic form for facility of reference. The corals, mollusca and some other groups of the fauna have already been recorded by Dr. T. S. Hall, M.A., and Mr. G. B. Pritchard, B.Sc., F.G.S.;[1] whilst a new echinoid *Echinoneus*[2] and also *Pentagonaster*[3] have lately been added by the former. Mr. Pritchard has described a new species of *Linthia*, which until recently had been confused with McCoy's "*Pericosmus gigas*" of the Murray River Cliffs.[4] I myself am responsible for the Foraminifera and the Ostracoda, which groups are now described in detail for the first time; one species of the former group, however, had already been figured and described in England by Messrs. Heron-Allen and Earland[5] under the name of *Bigenerina conica*, and Mr. W. Howchin gave generic names to several forms recorded in Messrs. Hall and Pritchard's paper referred to above. In the Spongida I record spicules of calcisponges and identify the species of *Isis* as the N. Zealand Tertiary form *I. hamiltoni*, which is, in Victoria, a typical Janjukian fossil. Arm ossicles of *(?) Antedon* have occurred in some of the washings of the disintegrated limestone. The Cheilostomatous Polyzoa have been revised and catalogued by Mr. C. M. Maplestone in his list of Fossil Cheilostomatous Polyzoa,[6] and some new species of the Cyclostomatous section have been described by the same author in a later

1 Proc. Roy. Soc. Vict., vol. iv., pt. i., n.s., 1891, p. 18; also a revised and extended list. Idem, ibid, vol. viii., n.s., 1896, p. 159.

2 Ibid, vol. xix., pt. ii., n.s., 1907, p. 47.

3 Ibid, vol. xv., pt. i., n.s., 1902, p. 81.

4 Ibid, vol. xxi., pt. i., n.s., 1908, p. 394.

5 Jour. R. Micr. Soc., 1909, p. 329.

6 Proc. Roy. Soc. Victoria, vol. xvii., pt. i., n.s., 1904, pp. 186-217.

paper.[1] The tooth of a shark, *Odontaspis contortidens*, Ag., was recorded with some reservation as from Batesford by Mr. Pritchard and myself in our paper on the "Fossil Fish Remains of the Tertiary of Australia, Pt. I."[2] I have since found this locality to be correct.

U. = Upper Quarry; F. = Filter Quarries; B. = Batesford, probably Filter Quarries.

FORAMINIFERA.

Miliolina oblonga, Mont., sp.	F.
" *vulgaris*, d'Orb., sp.	F.
" *polygona*, d'Orb., sp.	F.
" *ferussacii*, d'Orb., sp.	F.
Cyclammina complanata, Chapm.	F.
Textularia gibbosa, d'Orb.	F.
" " " " var. *tuberosa*, d'Orb.	F.
" *gramen*, d'Orb.	
Verneuilina ensiformis, sp. nov.	F.
Bigenerina (Siphogenerina) conica, H. A. and E.	F.
Spiroplecta siphonifera, Brady, sp.	U. F.
" *sagittula*, Defr., sp.	U. F.
" " " " var. *fistulosa*, Br.	F.
" *carinata*, d'Orb., sp.	F.
Gaudryina rugosa, d'Orb.	F.
Bulimina elegantissima, d'Orb.	F.
" " " " " var. *apiculata*, Chapm.	F.
Bolivina textilarioides, Rss.	F.
" *punctata*, d'Orb.	F.
" *limbata*, Brady.	F.
Cassidulina laevigata, d'Orb.	F.
" *calabra*, Seg., sp.	F.
" *subglobosa*, Brady.	F.
Ehrenbergina serrata, Rss.	F.
Lagena globosa, Mont., sp.	F.
" *favosopunctata*, Brady	F.
" *orbignyana*, Seg., var. *clathrata*, Brady	F.

1 Proc. Roy. Soc. Victoria, vol. xxi., pt. i., n.s., 1908, p. 233.
2 Ibid., vol. xvii., pt. i., n.s., 1904, p. 275.

Nodosaria (Dentalina) pauperata, d'Orb., sp.		F.
,, ,, ,, *consobrina*, d'Orb., sp.		F.
,, ,, ,, *soluta*, Rss., sp		F.
,, ,, ,, *obliqua*, L., sp.		F.
,, *scalaris*, Batsch, sp.		F.
,, *badenensis*, d'Orb.		F.
Cristellaria crepidula, F. and M., sp.		F.
,, ,, ,, ,, ,, var. *arcuata*, d'Orb.		F.
,, ,, ,, ,, ,, ,, *gladius*. Phil., var.		F.
,, ,, *articulata*, Rss., sp.		F.
,, ,, *rotulata*, Lam., sp.		F.
Polymorphina gibba, d'Orb.		F.
,, ,, *compressa*, d'Orb.		F.
,, ,, *oblonga*, d'Orb.		F.
,, ,, *elegantissima*, P. and J.		F.
,, ,, *regina*, P. B. and J.		F.
Uvigerina angulosa, Will.		F.
Globigerina triloba, Rss.		F.
Sphaeroidina bulloides, d'Orb.		F.
Spirillina cf. *inaequalis*, Brady		F.
Discorbina orbicularis, Terq., sp.		F.
,, *pileolus*, d'Orb., sp.		F.
,, *dimidiata*, P. and J.		F.
,, *valvulata*, d'Orb., sp.		F.
,, *biconcava*, P. and J.		F.
,, *polystomelloides*, P. and J.		F.
Planorbulina larvata, P. and J.	U.	F.
Truncatulina refulgens, Montf.. sp.		F.
,, ,, *lobatula*, W. and J., sp.		F.
,, ,, *variabilis*, d'Orb.		F.
,, ,, *tenuimargo*, Brady		F.
,, ,, *wuellerstorfi*, Schw., sp.		F.
,, ,, *ungeriana*, d'Orb., sp.		F.
,, ,, *reticulata*, Cz., sp.		F.
Anomalina ammonoides, Rss., sp.		F.
,, *grosserugosa*, Gümbel, sp.		F.
Carpenteria proteiformis, Goës.	U.	F.

Pulvinulina punctulata, d'Orb., sp.		F.
,, *concentrica*, P. and J.		F.
,, *partschiana*, d'Orb., sp.		F.
,, *elegans*, d'Orb., sp.		F.
,, *scabricula*, sp. nov.		F.
,, *pulchella*, d'Orb., sp.		F.
,, *schreibersii*, d'Orb., sp.		F.
Rotalia clathrata, Brady	U.	F.
,, *calcar*, d'Orb., sp.	U.	F.
Gypsina globulus, Rss., sp.		F.
,, *vesicularis*, P. and J., sp.		F.
,, *howchini*, sp. nov.	U.	F.
Polytrema minutum, sp. nov.		F.
Nonionina umbilicatula, Mont., sp.		F.
,, *boueana*, d'Orb.		F.
Polystomella subnodosa, Münster, sp.		F.
,, ,, *antonina*, d'Orb.		F.
,, ,, *crispa*, L., sp.		F.
,, ,, *verriculata*, Brady		F.
Amphistegina lessonii, d'Orb.	U.	F.
Operculina complanata, Defr., sp.	U.	F.
,, ,, ,, ,, var. *granulosa*, Ley.	U.	F.
Heterostegina depressa, d'Orb.	U.	F.
Cycloclypeus pustulosus, Chapm.	U.	F.
Lepidocyclina tournoueri, Lem. and Douv.	U.	F.
,, ,, *marginata*, Mich., sp.	U.	F.
,, ,, *martini*, Schlumberger	U.	F.

Spongida.

Spicules of calcisponges (indet.)	F.

Anthozoa.

Placotrochus deltoideus, Dunc.	F.
,, ,, *elongatus*, Dunc.	F.
Flabellum gambierense, Dunc.	F.
Isis hamiltoni, Thomson	F.

ECHINODERMATA.

(?) *Antedon* sp. (Arm ossicles). Pl. ii., figs. 8*a*, *b*. The arm ossicles in *Antedon* and *Pentacrinus* are closely similar. The balance of evidence seems here to be in favour of *Antedon*, since the basal portions of the crowns of this genus are known from Australian Barwonian strata, and it is well-distributed in the seas of the Southern Hemisphere at the present day; while *Pentacrinus* appears to be now nearly restricted to the W. Indian seas.	U. F.	
Pentagonaster sp.	F.	
Cidaris (? Leiocidaris), sp.	F.	
Spines of a cidaroid, indet.	F.	
Psammechinus woodsi, Laube, sp.		B.
Echinocyamus (Scutellina) patella, Tate, sp.		B.
Clypeaster gippslandicus, McCoy	U. F.	
Arachnoides (Monostychia) australis, Laube, sp.	F.	
Linthia mooraboolensis, Pritchard	U. F.	
,, sp., near *gigas*, McCoy	F.	

POLYZOA (CYCLOSTOMATA).

Berenicea nitida, Maplest.	F.
Idmonea concinna, Maplest.	F.
,, *angustata*, Maplest.	F.
Entalophora sparsa, Maplest.	F.
,, *quadrata*, Maplest.	F.

(CHEILOSTOMATA).

Canda fossilis, Lamz.	F.
Cellaria contigua, McGill.	F.
Amphiblestrum crassissimum, Maplest.	F.
,, ,, *robustum*, Maplest.	F.
Lunulites parvicella, T. Woods, sp.	F.
Selenaria concinna, T. Woods	F.
,, *marginata*, T. Woods	F.
Thalamoporella patula, Waters, sp.	F.

Steganoporella magnilabris, Busk		F.	
Cribrilina terminata, Waters		F.	
Tessaradoma elevata, Waters, sp.		F.	
Adeona obliqua, McGill.		F.	
Smittia macgillivrayi, Maplest., sp.		F.	
,, *tatei*, T. Woods, sp.		F.	
Mucronella conica, Maplest.		F.	
,, *lata*, McGill		F.	
Porina gracilis, Milne Edw., sp.		F.	
Retepora rimata, Waters		F.	

BRACHIOPODA.

Crania quadrangularis, Tate			B.
Rhynchonella squamosa, Hutton		F.	
Terebratulina catinuliformis, Tate	U.		
,, ,, *scoulari*, Tate			B.
Magasella compta, Sow., sp.		F.	
,, (?) *woodsiana*, Tate		F.	
(?) *Magellania garibaldiana*, Dav., sp.	U.	F.	
,, ,, *divaricata*, Tate, sp.			B.
Magellania macleani, Tate, sp.			B.
,, *furcata*, Tate, sp.			B.
Terebratula vitreoides, T. W.			B.

PELECYPODA.

Nucula sp.	U.		
Glycimeris cainozoicus, T. W., sp.			B.
Ostrea sp.	U.	F.	
Pecten murrayanus, Tate	U.	F.	
,, *polymorphoides*, Zittel		F.	
,, *consobrinus*, Tate, var.	U.		
,, sp.			B.
Spondylus pseudoradula, McCoy.	U.		
Lima (*Limatula*) *jeffreysiana*, Tate			B.
Septifer fenestratus, Tate			B.
Dosinea densilineata, Pritchard			B.
Mactra howchiniana, Tate			B.

GASTEROPODA.

Patella sp.			B.
Pleurotomaria, sp. (cast)			B.
Tenagodes sp.			B.
Also casts of other spp., indet.	U.		

OSTRACODA.

Pontocypris attenuata, Rss.		F.	
Bythocypris reniformis, G.S.B.		F.	
Bairdia amygdaloides, G.S.B.	U.	F.	
,, *foveolata*, G.S.B.		F.	
Cythere wyville-thomsoni, G.S.B.	U.	F.	
Loxoconcha alata, G.S.B.		F.	
Xestoleberis curta, G.S.B., sp.		F.	
(?) Cytheropteron angustatum, G.S.B.		F.	
Cytheropteron batesfordiense, sp. nov.		F.	
Chelæ of Crustacea, indet.			B.

PISCES.

Odontaspis contortidens, Ag. U.

(This specimen was recorded in the paper on Australian Tertiary Sharks' teeth by Mr. G. B Pritchard and myself, with a query as to the locality. I am now able to recognise the characteristic *Lepidocyclinae* in the hard, dark coloured matrix of the specimen, and this confirms the locality as Batesford, Upper Quarry).

Oxyrhina retroflexa, Ag. F.

(About 24 teeth, originally many more, in a block of *Lepidocyclina* limestone measuring 45 cm. × 35 cm. × 14 cm., associated with shells of *Pecten* spp. and a tooth of *Carcharodon megalodon*, presented to the National Museum by Mr. W. B. McCann).

Carcharodon megalodon, Ag. F.

CETACEA.

Vertebral epiphyses, probably of a whale B.

CALCAREOUS ALGAE.

Lithothamnium, 2 spp. One form is small and has knobby or tufty branches; the other is explanate, thin and encrusting U. F.

A large portion of the present paper is devoted to the description of two groups of fossils from the Batesford Limestone which have been somewhat neglected—viz., the Foraminifera and the Ostracoda. Of the first group, the sub-family of *Orbitoidinae* affords direct and convincing evidence as to the homotaxial equivalents of the beds in question; and this evidence, taken in conjunction with the occurrence of other fossil forms which are restricted to more or less definite palaeontological horizons, points to the correlation of the Batesford series of the Victorian tertiaries with the Middle Miocene of Europe, Asia and the East Indies.

The great abundance of the nummulinoid genus *Amphistegina* in our tertiary strata is additional proof of their homotaxial relationship with the Miocene elsewhere. As my revered friend, Prof. Rupert Jones, has pointed out to me, the result of a unique experience of European microzoic tertiary faunas, the genus *Amphistegina*, with its inequilateral test, took the place of the equilateral Nummulite towards the close of the great Nummulitic period, and flourished in prodigious abundance in Miocene times.[1] The Miocene forms of *Amphistegina* are, moreover, curiously simulant of the nummuline test, as they are often of large size, and flattened lenticular in contour, as distinguished from the living forms, which are typically smaller, stouter and more dome-shaped. Hence the confusion of *Amphistegina* in Australian rocks with the smaller species of *Nummulites* as *N. variolaria*.

1 The genus *Nummulites* attained its maximum development in middle Eocene times, as shown by its abundant species and large size (e.g., *N. complanata*, with a test often exceeding 2¼ inches in diameter). It occurs more sparingly in Oligocene strata, and is occasionally found as high in the series as the middle Miocene and represented by *N. niasi*. The recent species of the genus show some affinity with *Operculina* and *Amphistegina*.

Among the Batesford echinoids the genus *Linthia* calls for a few remarks. Its distribution is from the Cretaceous to Recent, but it is typically Miocene, and its maximum development was attained at that period. In conformity with the recognised law of increase of size in phyletic branches, the genus *Linthia* affords an interesting case in point. It probably attained its largest dimensions in *L. gigas*, McCoy sp., from the Murray Cliffs, the type specimen having a length of seven and a-half inches.[1] The stratum in which it occurs is of Barwonian age (i.e., Balcombian or Janjukian), but presumably Janjukian.

Of the twentv-three spp. of polyzoa recorded from Batesford bv Mr. C. M. Maplestone, four species are found living—viz., *Selenaria concinna* (S. Australia), *S. marginata* (S. Australia), *Steganoporella magnilabris* (Australia, N. Zealand and Japan), and *Porina gracilis* (Australia). Thus the ratio of living to fossil forms is 17 per cent.

The brachiopod, *Rhynchonella squamosa*, Hutton, is still living S. of Kerguelen Island.[2]

The comparatively modern aspect of the Janjukian strata is shown by the group of the ostracoda. Of the nine species here recorded, one is new, whilst eight are living at the present day. The distribution of these living species ranges from Kerguelen Id. to Torres Strait, the Indian Ocean and the China Seas; whilst one species is found in the Atlantic. Three have been recorded from Bass Strait and two from Port Jackson.

Although the species of sharks, represented in the Batesford Limestone by teeth, are not numerous, they possess a special interest. Perhaps the most important is *Oxyrhina retroflexa*, by far the commonest form. This species is found in several other localities where beds of similar age are exposed, and it also occurs in the remanié or nodule beds of the Grange Burn and Beaumaris, whose material was probably derived from an underlying Janjukian stratum. This same species, *O. retroflexa*, occurs in the Oamaru Stone of the S. Island of N. Zealand, and described under the name of *Oxyrhina vonhaasti* by

1 This species was recorded also from Corio Bay in error for Batesford (Prod. Pal. Vict., dec. vii., 1882, p. 16). The specimen has the test badly crushed, but shows some characters intermediate between *L. gigas* and *L. mooraboolensis*, Pritch.

2 See Hutton, Trans. and Proc. N.Z. Institute, vol. xxxvii., 1905, p. 481.

J. W. Davis.[1] Certain other typical fossils of the Oamaru Series are also common to the Janjukian of southern Australia, and the Oamaru Stone horizon in particular appears to be homotaxial with the Batesford Limestone. A recent writer on this subject, Prof. J. Park,[2] has summarised the latest evidence, both stratigraphical and palaeontological, and he places the Oamaru Stone in the Miocene, at about the middle of that series. This opinion independently supports my own conclusion as to the age of the Batesford beds. Besides the species of shark just mentioned, both the Mount Brown Beds and the underlying Oamaru Stone contain the remarkable cetacean type, *Kekenodon onomata*, Hector, which, from the structure of the fangs and the rounded contour of the crowns of the molars are undoubtedly of the squalodont form, although the species has always been referred to as a zeuglodont. In his description of this fossil, Hector, however, does state that the New Zealand teeth resemble, amongst other genera, those of *Squalodon*.[3] The Janjukian of Waurn Ponds, and Castle Cove, Cape Otway, occasionally yield the teeth of *Squalodon wilkinsoni*; and these show a close relationship with the New Zealand fossils, with the exception that the latter are much larger, and the canines more trenchant and strongly curved. Moreover, from the Oamaru Series at White Rock River Quarry, N.Z., Davis has described a denticulated tooth of a true squalodont, which he refers to a new species, *Squalodon serratus*,[4] at the same time remarking that it shows great relationship with McCoy's *S. wilkinsoni*. The molar tooth from the polyzoal rock of Mt. Gambier, named *Zeuglodon harwoodi* by Mr. E. B. Sanger, is also closely related, if not identical with the Victorian *Squalodon*.[5] In its bearing on the age of the Janjukian it is interesting to note that the genus is typical of the Miocene series of France and Bavaria, and remains have also been found in European Pliocene strata. The pennatulid *Graphularia*, is another guide-fossil common to the Middle Oamaru Series and the

1 Trans. R. Dubl. Soc., ser. ii., vol. iv., 1888, p. 26, pl. iv., figs. 1-3.
2 Trans. and Proc. N.Z. Institute, vol. xxxvii (1904), 1905, pp. 489-551
3 Ibid, vol. xxx. (1880), 1881, p. 435.
4 Trans. R. Dubl. Soc., ser. ii., vol. iv., 1888, p. 4, pl. vii., fig. 9.
5 Proc. Linn. Soc. N.S. Wales, vol. v., 1881, p. 298.

Victorian Janjukian Beds. Other closely allied fossils are a species of *Linthia* from the Oamaru Series of the Geraldine District, N.Z., and *L. mooraboolensis*, Pritch., from Batesford; and the "*Celleporina*" (*Cellepora*) *papalosa* from the Oamaru Series and a similar, but undescribed form in the polyzoal rock of Victoria and S. Australia.

Summary, and Conclusions as to the Age of the Beds.

1.—The Batesford Limestone Series includes a *Lepidocyclina* and a polyzoal, facies, there being a gradual transition from one to the other. They were evidently formed at one continuous period of sedimentation, the palaeontological differences being due to the deepening of the water during the formation of the polyzoal banks in this area. In other localities, however, the polyzoa, by the abundance of the more massive forms, show evidence of shallower conditions.

2.—This series is of Janjukian age, as shown by Messrs. Hall and Pritchard; and corresponds to the widespread stage of the polyzoal rock which represents a comparatively distinct phase in the Tertiary history of Victoria.

3.—By the presence of *Lepidocyclinae* of the *L. marginata* type, accompanied by *L. tournoueri* and *L. martini*, as well as by *Cycloclypeus pustulosus*, the limestones are shown to be the homotaxial equivalents of the Burdigalian beds as developed in Southern Europe (Faluns de Saint-Paul, near Dax), and in Java, Sumatra, Borneo and the New Hebrides.

4.—The modern character of the beds is indicated by the Ostracoda, which are all, with the exception of one new species, of living types.

5.—By comparison, the Keilor *Lepidocyclina* Limestone appears to be on a slightly lower horizon of the Janjukian series than that of Batesford, as shown by the addition to the Batesford *Lepidocyclina* fauna, of *L. verbeeki*, a form also occurring in a still lower stage at Clifton Bank, Muddy Creek, near Hamilton. The Gaj Beds of India I would refer to this, Keilor, horizon, which in the case of the Indian beds, is regarded by Vredenburg as probably Upper Aquitanian. The *L. insulae-natalis* beds of Christmas Id., in all probability, also belong here.

6.—The Batesford beds, in common with other Janjukian strata, occupy a middle position in our Tertiary series, and are younger than the richly fossiliferous Balcombian clays and sands of Mornington and Muddy Creek (Lower Beds).

In conclusion, I desire to express my sincere thanks to Dr. T. S. Hall, M.A., for many specimens and samples of foraminiferal material with which I began the examination of the microzoa of these quarries. I am also indebted to Mr. G. W. Cortous, of Geelong, for kindly supplying me with further fossiliferous material; as well as Mr. W. B. McCann, as before mentioned.

The types of the new species and representative specimens have been presented to the National Museum collection.

EXPLANATION OF PLATES.

Plate LII.

Fig. 1—*Verneuilina ensiformis*, sp. nov. 1*a*, lateral aspect; 1*b*, oral aspect. Filter Quarry. × 58

2—*Pulvinulina scabricula*, sp. nov. 2*a*, superior face; 2*b*, peripheral view. Filter Quarry. × 58.

3—*Polytrema minutum*, sp. nov. 3*a*, superior aspect; 3*b*, side view. Filter quarry. × 29.

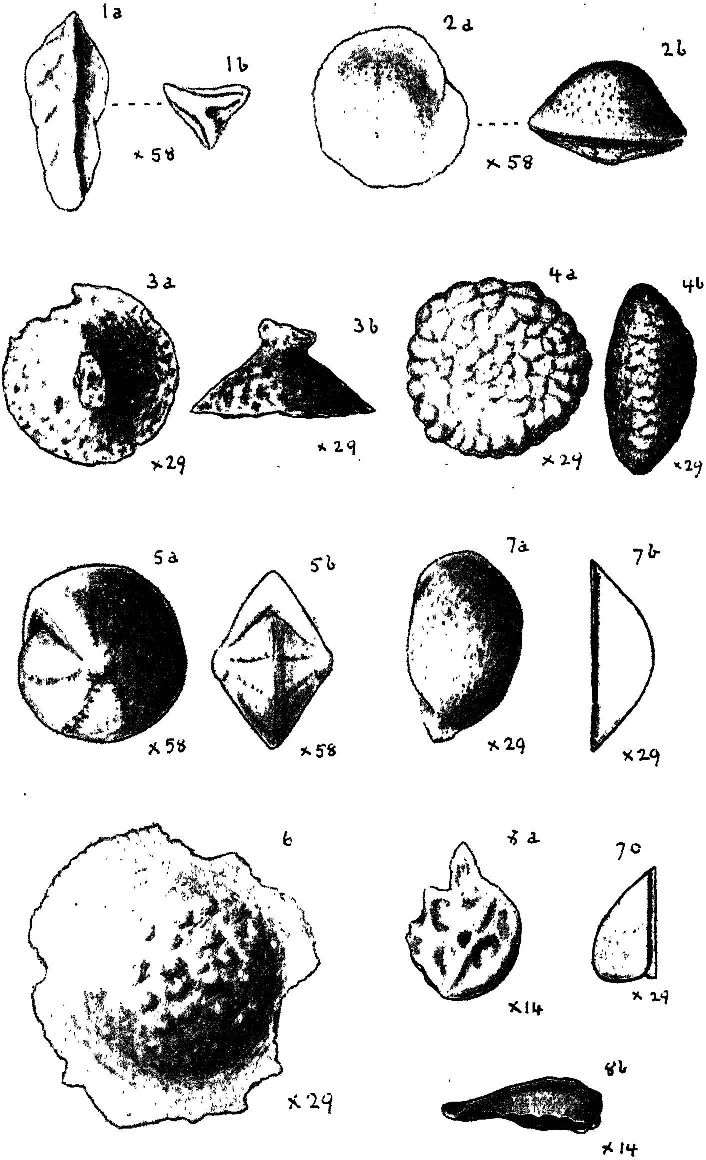
4—*Gypsina howchini*, sp. nov. 4*a*, lateral aspect; 4*b*, peripheral aspect. Filter quarry. × 29.

5—*Polystomella antonina*, d'Orbigny. 5*a*, lateral aspect; 5*b*, oral aspect. Filter quarry. × 58.

6—*Cycloclypeus pustulosus*, Chapm. Lateral aspect. Filter Quarry. × 29.

7—*Cytheropteron batesfordiense*, sp. nov. 7*a*, lateral aspect of left valve; 7*b*, ventral aspect; 7*c*, end view. Filter Quarry. × 29.

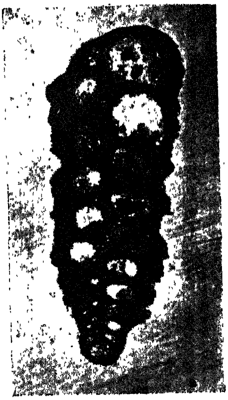
8—(?) *Antedon*, sp. Arm ossicle. 8*a*, distal face of the epizygal; 8*b*, edge view, showing crenulated edge of the radially marked proximal face. Filter Quarry. × 14.



F.C. ad nat. del.

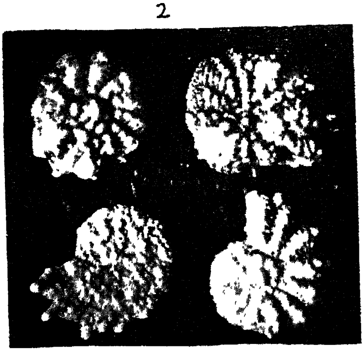
Fossils from the Batesford Limestone.

1



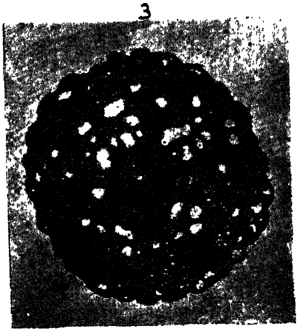
×40

2



×18

3

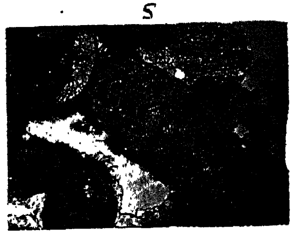


×40

4

×40

5



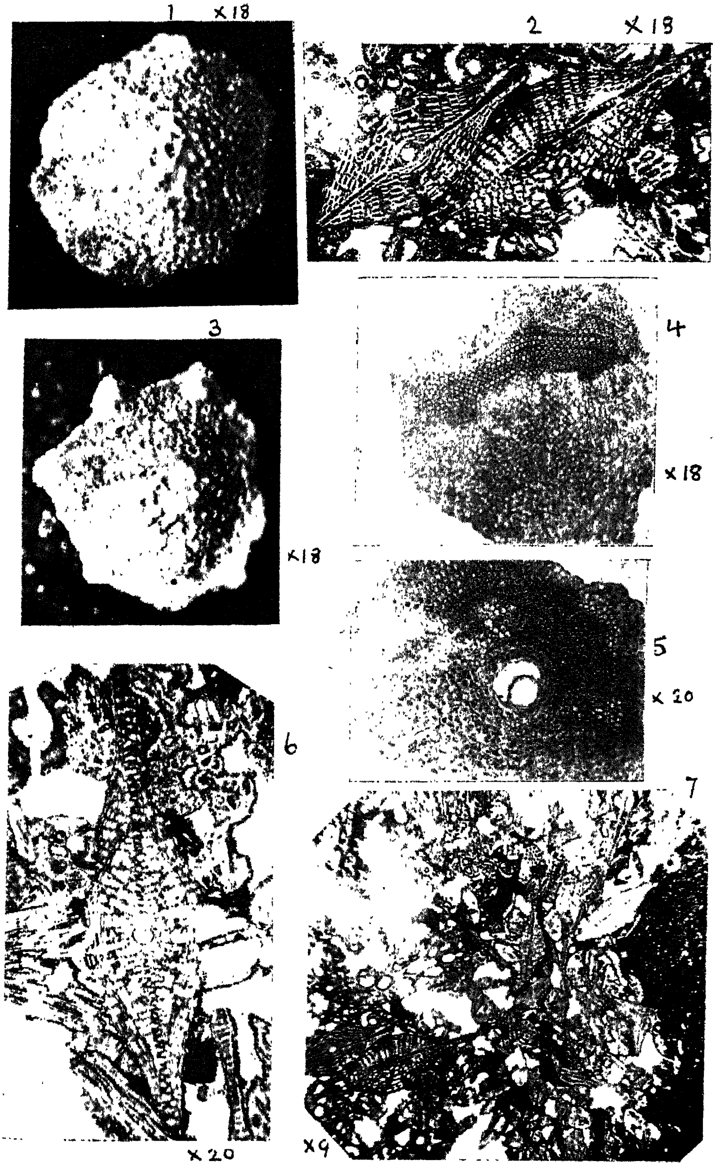
×40

6

×40

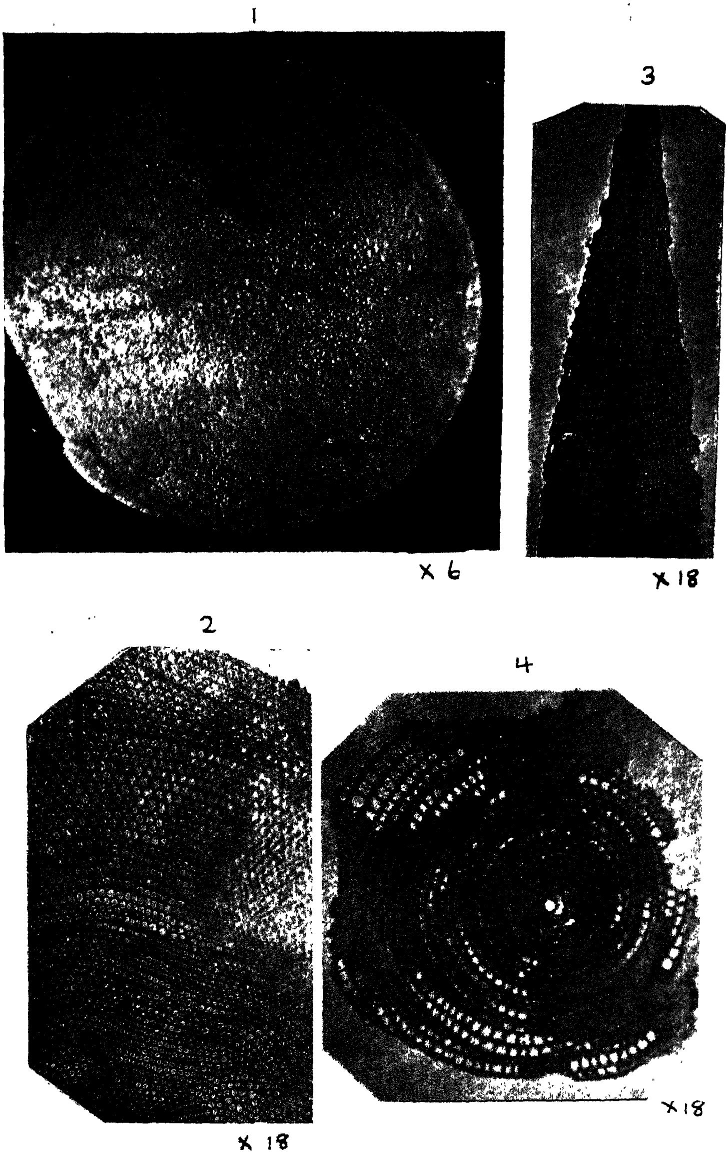
F. C. photomicr.

Spiroplecta, Rotalia, Gypsina, and Amphistegina, from the Batesford Limestone.



F. C. photomicr.

Lepidocyclinæ and Lepidocyclina-Limestone from Batesford.



F. C. photomicr.

Lepidocyclina and Cycloclypeus from the Batesford Limestone.

Plate LIII.

Fig. 1—*Spiroplecta siphonifera*, Brady, sp. Median vertical section passing through the megasphere, and showing the spiroplectoid commencement. Filter Quarry. × 40.

2—*Rotalia calcar*, d'Orb., sp. Four examples showing the redundant papillose shell-growth and the calcarine periphery. Filter Quarry. × 18.

3—*Gypsina howchini*, sp. nov. Median section of test, showing the crowded initial series of chambers. Upper Quarry, near Batesford. × 40.

4—*G. howchini*, sp. nov. Median section of test vertical to the disc, shewing megasphere. Upper Quarry, near Batesford. × 40.

5—*G. howchini*, sp. nov. Another specimen in vertical section, showing a tendency to develop a median line of chambers as in *Miogypsina*. Upper Quarry, near Batesford. × 40.

6—*Amphistegina lessonii*, d'Orb. Section in limestone parallel with the umbilical axis; showing the asymmetry of the test as distinct from *Nummulites*. Upper Quarry, near Batesford. × 40.

Plate LIV.

Fig. 1—*Lepidocyclina tournoueri*, Lemoine and R. Douvillé. Lateral aspect. Filter Quarry. × 18.

2—Vertical sections of *Lepidocyclina martini*, Schlumberger (left hand figure), and *L. tournoueri*, Lem. and Douv.; in limestone from the Upper Quarry, near Batesford. × 18.

3—*Lepidocyclina martini*, Schl. Lateral aspect. Filter Quarry. × 18.

4—*L. martini*, Schl. Median transverse section of test, showing chamberlets of both superficial and median layers. Filter Quarry. × 18.

5—*Lepidocyclina marginata*, Michelotti, sp. Median section, passing through the megasphere. Filter quarry. × 20.

6—*L. tournoueri*, Lem. and Douv. Vertical section, passing through the megasphere. From limestone of the Upper Quarry, Batesford. × 20.

7—Typical microscope section of the Batesford Limestone (Upper Quarry), showing the relative abundance of the *Lepidocyclinae*. × 9.

PLATE LV.

Fig. 1—*Lepidocyclina marginata*, Michelotti, sp. Lateral aspect. Filter Quarry. × 6.

2—*L. marginata*, Mich., sp. Portion of a section through the median layer of chamberlets; showing the spatulate ends of the same. Filter Quarry. × 18.

3—*L. marginata*, Mich., sp. Vertical section of test, showing the thin pillars and crowded chamberlets. Filter Quarry. × 18.

4—*Cycloclypeus pustulosus*, Chapman. A transverse median section, passing through the megasphere. Filter Quarry. × 18.

[PROC. ROY. SOC. VICTORIA, 22 (N.S.), PART II., 1909.]

ART. XXI.—*Contributions to the Flora of Australia, No. 13.*

BY ALFRED J. EWART, D.Sc., PH.D., F.L.S.;

AND

JEAN WHITE, D.Sc.

(With Plates LVI.-LX.).

[Read 9th December, 1909].

ALLIUM SCORODOPRASUM, L. (Liliaceae). "Sand Leek.

Greenvale, North-eastern district, Victoria. James Musgrove, November, 1908 and 1909.

A native of Europe and Western Asia, and now may be considered as naturalized in Victoria. The umbel is occasionally reduced to a head of bulbs without any flowers. These maintain the plant locally, but do not spread it in the same way that seed do. Old bulbs will usually flower, especially after being dried off. The plant is not poisonous or actively injurious, but is a useless weed, capable of becoming troublesome if neglected.

ANGIANTHUS AXILIFLORUS (W. V. Fitzgerald, MS. ined.), Ewart and White, n. sp. (Compositae).

Rather rigid herbs 3-4 inches in height. There is one woody mainstalk which gives off short lateral branches from the axils of the alternate leaves. Leaves very pale green, only very few on the main stem, but crowded and tuft-like on the short lateral branches; 3-5 lines long, sessile, slightly ensheathing at the base, linear-lanceolate, glabrous and somewhat rigid and pointed.

Inflorescence of lateral or terminal compound heads. Each compound head is surrounded by a number of leaf-like glabrous

bracts, which form a general involucre. There are 5-8 partial heads in each compound head, and the whole is 3 to 6 millimetres in diameter.

Each partial head is 1 or 2 flowered, and is surrounded by 6 scarious and quite glabrous bracts, of which the two outermost are small, one extremely so, being only just visible to the naked eye. Of the 4 larger surrounding bracts the 2 lateral ones are somewhat conduplicate, and the 2 inner are slightly concave. The partial heads are very shortly stalked.

The achene is short, nearly as broad as long, with no sign of a break, flattened and covered with fairly long white hairs.

A pappus is present in the form of a ring of short white bristles surrounding the base of the corolla tube. Base of the floret slightly thickened, corolla 5-toothed, pale yellow in colour, Anthers finely tailed at the base, style branches not thickened, not spreading.

Cowcowing, W. Australia. Max Koch, Oct., 1904. No. 1196.

This species was received, marked W. V. Fitzgerald inedit. from both the collector and the Sydney Herbarium. It appears to be a valid new species, but no published description has hitherto been issued. The affinities of the plant are somewhat difficult to define, but in the bracts of its partial heads, and in the pappus, it comes nearest to *A. brachypappus*, F. v. M., and is probably best placed between that species and *A. pleuropappus*, though differing widely from both plants in its external habit and glabrous character.

Aster subulatus, Michx. (Compositae).

An American weed introduced into Victoria from N.S. Wales, where it is common, and has long been known as *A. dumosus*, L.

As the identification appeared doubtful, in 1906, after consulting the Sydney Herbarium, reference was made to Kew, where the identification was confirmed, and the name recorded by me (Proc. Roy. Soc. Vict., xix., 34, 1906) on the basis of these authorities.

The Gray Herbarium, however, refers it to *Aster subulatus*, Michx., from specimens forwarded by the Sydney Herbarium. This identification is accepted by Mr. Maiden (Proc. Linn. Soc.

of N.S. Wales, 1909, 34, p. 363), and appears to be correct. Victorian specimens also agree closely with some from the Paris Museum, marked *Tripolium conspicuum*, D.C., which in the Botany of California is made *A. divaricatus*, Nutt, so that a further question of synonymy arises. The Victorian specimens are close to, without exactly matching, those of *A. divaricatus*, Nutt, but throughout the whole genus we have variable species with badly-defined boundaries. *Aster dumosus* differs from *A. subulatus* in its blunter, more obtuse bracts.

CALADENIA IXIOIDES, Lindl. = C. GEMMATA, var. IXIOIDES. (Orchideae).

Upper Swan R., Miss Sewell, 1883; Woorooloo, W. Australia, Max Koch, Dec., 1906. The plant is merely a yellow flowered variety of the blue flowered *C. gemmata*. Bentham (Flora Austr., p. 389) retained the species, but admitted it might be a variety only. Fitzgerald (Australian Orchids) found the floral structure so identical with that of *C. gemmata* as not to need a separate plate, but considered the species should be retained for the convenience of collectors.

Slight variations in the shape of the labellum occur in the blue flowered forms of *C. gemmata* as well as in the yellow ones. The latter appear to be rarer, and of localised distribution. Since yellow is a more primitive colour than blue, the yellow form is probably the original type, and has been suppressed by the blue forms whenever they have come in contact, the two forms not appearing to grow together.

It is not possible to distinguish herbarium specimens of these two "species" if the colour has been completely lost.

CALADENIA ROEI, Benth.

The leaves up to 4½ inches in length. Cowcowing, W. Australia. Max Koch, Dec., 1904.

CALOCEPHALUS SKEATSIANA, Ewart and White, n. sp. (Compositae). After Professor Skeats.

A small, somewhat woody plant about 4-7 inches in height, branching freely from the base. All the stems, especially when

young, are more or less covered with white hairs. The leaves are $\frac{1}{4}$-$\frac{1}{2}$ an inch long, with short petioles and densely covered on both surfaces with soft, woolly, white hairs, linear-lanceolate, flat, slightly pointed, alternate, a few opposite. Flower heads compound on short axillary branches springing from the main branches or from the secondary ones. The diameter of each compound head almost spherical, 3-4 millimetres diameter, but possibly larger when fully ripe. The peduncles and outer bracts of the involucre are densely covered with white hairs. There are only a few bracts in the general involucre; 2 or 3 of the outermost are almost leaf-like, have a filiform scarious tip, and are covered on both sides with long, soft white hairs. The other bracts of the general involucre have a leaf-like centre with scarious margins, a bunch of hairs each side, and conspicuous, scarious, not radiating tips. The receptacle is apparently branched. There are 3-4 partial heads in each compound head, and each is very distinct and very slightly flattened, being almost round in outline. There are 20-30 bracts round each partial head, all of which have radiating tips and are exactly similar to the inner bracts of the general involucre. The more central bracts of the partial heads have thin scarious tips incurving over the top of each partial head. Inside the innermost bract is a small cavity in which are situated 3-8 florets, with a quantity of upright soft, white woolly hairs between them. Each flower appears to be hermaphrodite, but the achene is very deciduous in the dried specimens. The achene is very small, obtuse at the tip, and is slightly hairy. The pappus consists of a varying number of long, plumose, soft, woolly white strands, which may or may not be very slightly united at the base to form an imperfect ring. The corolla is pale yellow, and 5-toothed; the floret is thickened at the base. The anthers are united, and have short, fine tails. The style is divided into two branches, which are spreading and are not thickened at their bases.

Watheroo Rabbit Fence, West Australia. M. Koch, Dec., 1906. No. 1544.

A specimen from the Plantae Preissianae of Lehmann (vol. i., p. 490, No. 71) is allied in some respects to this species, but being without fully developed flowers, cannot be exactly placed.

Lehmann remarks:—"Plantae quoad genus omnino dubia; fortasse ad Angiantheas referenda," but as far as can be determined from the heads, bracts and immature pappus, it more closely resembles *Calocephalus*. It differs from the present plant in the indumentum, shape and position of leaves, shape and number of bracts, etc.

Calocephalus Skeatsiana differs widely in external appearance from all other species of *Calocephalus*, but nevertheless in the involucre, bracts, partial heads, pappus, etc., comes within the range of this genus, and older specimens will probably approach Calocephalus more closely in external appearance. It has been named *Eriochlamys Knappi*, F. v. M., in W. Australia, but is quite different to that species externally and in the heads and involucre, though alike in the florets and in the presence of a pappus.

CALYSTEGIA (CONVOLVULUS) SOLDANELLA, L. (Convolvulaceae).

Three-mile Beach, National Park, Audas and St. John, Oct., 1909.

This cosmopolitan plant is found on the shores of all the temperate regions of the globe. The sole Victorian record was from Wilson's Promontory, by Mueller, in May, 1853, of a doubtful non-flowering specimen, placed by him as a variety "reniformis" of *C. sepium*. The plant is not recorded from any other locality in Victoria. but there is no reason to doubt its being native to the present locality. It helps to bind the sand on sea coasts.

CASUARINA DISTYLA, Vent., var. PROSTRATA, Maiden and Betche.

Audas and St. John, Wilson's Promontory, Oct., 1909.

The variety has the branchlets finely hairy, and has not previously been recorded from Victoria.

ERIOCHLAMYS KNAPPII, F. v. M. = CALOCEPHALUS KNAPPII (F.M.), Ewart and White. (Compositae).

This plant differs from Eriochlamys Behrii, the only species of this genus, in:—

(1) The compound heads are very strongly developed.

(2) The florets have a pappus of fine hairs, plumose at the tip, as in Calocephalus Skeatsiana.

(3) The outer bracts of the partial heads are small, narrow, are green and opaque, with scarious tips. The inner ones are completely scarious, and are very narrow, with conspicuous tips.

In Calocephalus Skeatsiana, the partial heads are still more strongly developed, with a marked general involucre, and the bracts of the partial heads are somewhat similar, with a green foliose centre, scarious margins, and non-radiating tips. In both species there is a strong development of fine wool on the bracts around the partial heads.

Probably *Eriochlamys Behrii*, S. and M., is not the only species of this genus in Australia. A specimen from Balonne, R. Henry Wehl, 1896, has the outer and inner bracts resembling those of *Eriochlamys*, and has an undeveloped pappus. The material is, however, insufficient for description.

Calocephalus Knappii is known from the following localities: Finke R., South Australia, Rev. H. Kempe, Dec., 1879, 1880 and 1882. Between Gascoyne and Fortescue Rivers, H. S. King, 1885.

GALIUM MURALE, All. (Rubiaceae).

This small plant, a native of the Mediterranean region, is often overlooked on account of its rather small size, but is now frequent in springtime, especially in pastures.

North-west, West and South-west of Victoria. F. M. Reader, 1909.

HAKEA PRITZELII, Diels.; Fragm. Phytog. Austr. Occid., p. 163 = H. GLABELLA, R. Br., sub-species H. PROSTRATA, R. Br.

The Melbourne Herbarium contains a perfect series of transitions between this variety or sub-species and the type *H. glabella*. These specimens, including several originally named *H. amplexicaulis*, and partly transferred by Bentham, partly by Mueller to *H. glabella*, including Oldfield's Murchison R. specimen, were apparently overlooked by Diels, and in any case if a new species is to be raised it would need to be under the name *H. prostrata*, R. Br., although the original description is short

and the name not particularly appropriate. Size, scent, colour and habit are among the less satisfactory features on which to base species.

HALGANIA LEHMANNIANA, Sond. In Plantae Preissianae, vol. ii., p. 238, (1846-7). (Solanaceae).

Bentham (Flora Australiensis, vol. iv., p. 401), although he had not seen a specimen, considered from the published description that the plant was a form of *H. Preissiana.* The Kew Index similarly suppresses the species. It is, however, valid, differing from *H. Preissiana* in the indumentum, shape of the leaves, smaller flowers and glabrous calyx, with less sharply pointed segments. In *H. Preissiana* the leaves and stems are sprinkled with large, simple, whitish, suppressed hairs, which are replaced in *H. Lehmanniana* by a scurfy tomentum, mainly on the stems, of very short, erect, branching or stellate hairs.

HALGANIA TOMENTOSA, R. Helms M.S., Ewart and White, n. sp.

West of Red Kangaroo Hill, R. Helms, November, 1891.

A somewhat woody herb 5-10 inches high in the specimens examined. Stems wiry, densely beset with rather short, white, felt-like hairs. Leaves rather thick in texture, 2-5 lines long, shortly petiolate, entire margins, alternate; like the stem, covered thickly with white, felt-like hairs, midrib hardly visible on the under surface, vertical, and with a palisade layer on both surfaces. Pedicels 3-6 lines long, and covered with brown, felt-like hairs. Flowers solitary, terminal, each with a small brown bract, each flower about 4 lines in diameter. Calyx lobes 5, except at the extreme base, 1.5-2 lines long, the outside covered with short brown hairs, narrow, and only very slightly obtuse. Petals 5, broad, acute, free except at the extreme base, exceeding the calyx lobes, probably blue, but fading to brown in dried specimens. Anthers slightly pubescent, the lobes not very conspicuous, about 3 lines long.

Ovary 2-celled, style long and slender. Fruit a superior, dry, 2-chambered capsule about 2.5 lines long, with the style persistent.

This species is apparently nearest to *Halgania Solanacea*, from which it differs in the following respects:—

(1) Leaves less obtuse, smaller, thicker in texture, much more densely beset with white felt-like hairs, and the midrib not prominent underneath.

(2) Calyx lobes narrower, less obtuse, and less than 3 lines long.

(3) Flowers mostly solitary, and terminal.

(4) Anther lobes are less distinct from each other.

EUCALYPTUS LEUCOXYLON, F. v. M. (Myrtaceae).

Dr. Woolls (Proc. Linn. Soc. of N.S. Wales, vol, 1, 2nd ser., 1886, p. 861) first showed that under this head Mueller and also Bentham wrongly included the S. Australian White Gum and the Red Flowering Ironbark. The name of *E. Leucoxylon* can be restricted to the former, as proposed, but if the name *E. sideroxylon* is to be given to the Red Flowering Ironbark, it cannot be given on A. Cunningham's authority. In the Kew Index, and in Baker's Research on the Eucalypts, p. 111, and also in Benth. Flora, the reference is given as E. sideroxylon, A. Cunn., in Mitch. Trop. Austr., 339 (name only). The reference actually is, "Among the larger forest trees was a Eucalyptus, allied to, but probably distinct from, the *E. sideroxylon*, A. Cunn." This is a most curious reference on which to base a species, a casual reference to a name by another writer. Dr. Woolls does not give a formal description, but details the differences between the two species very fully, and the name can only stand on his authority as C. sideroxylon, Woolls.

Mr. Baker (l.c., p. 111) notes as a specific distinction that the rim of the capsule soon becomes detached in *E. sideroxylon.* The same applies, however, to *E. Leucoxylon*, as is well shown in specimens forwarded by Mr. A. D. Hardy from Studley Park, Oct., 1909, but this does not affect the validity of the two species. As in many Eucalypts, the length of the style varies in different flowers of *E. sideroxylon* even when taken from the same tree.

GREVILLEA HELMSII, Mueller and Tate in Tr. of the Roy. Soc. of S.A., vol. xvi., p, 351 (1896), also Botan. Centrlb. lxv., No. 11 (1896) = G. PLURIJUGA, Mueller in Fragm. iv., p. 84 (1863-4). (Proteaceae).

Diels, in Engler's Bot. Jahrb. Bd., xxxv., p. 150, 1905 (Fragmenta Phytographia Australia Occidentale, p. 150), was unable to distinguish between these two species. The only difference appears to be in the greater tendency to hairiness in the pedicels and outside of the perianth in the "Helmsii" specimens, in which, perhaps, the flowers are also a trifle larger. Anthers, disk, torus, ovary, stigma and leaves are identical. The perianth and pedicels of *G. plurijuga* are not entirely glabrous, as stated in the original description.

LINARIA PELLISERIANA, L. (Scrophulariaceae). "Pelisser's Toad Flax."

This plant was recorded in 1908 from the Mitta Mitta R., and Chiltern. It appears to be spreading in paddocks at Sandy Creek, Wodonga, and is undoubtedly naturalized as an alien. It is a native of S. Europe and Asia Minor.

LINDSAYA TRICHOMANOIDES, Dryander. (Filices).

Collected National Park, Wilson's Promontory, 28/10/09, by Dr. Sutton, J. W. Audas and P. R. H. St. John.

This forms an addition to the Flora of Victoria, being only recorded previously from Tasmania and N.S. Wales. It appears to be rare in all the localities where it occurs, and is the third case of a member of the Victorian Flora having its sole and only Victorian locality in the National Park.

MACADAMIA VERTICILLATA, F. v. M.; ex Bentham's Flora Australiensis, vol. v., p. 207 (HELICIA VERTICILLATA, F. v. M., Fragm. vi., 191. (Proteaceae). = BRABEJUM STELLATIFOLIUM, L.

This plant, collected by Leichardt, is given in Bentham's Flora as from Queensland or N.S. Wales, precise locality unknown.

The plant is not recorded in the Floras of either Queensland or New S. Wales. Mueller noted (Fragm., viii., 150) its resemblance to the S. African *Brabejum stellatifolium*, L., and suggested that this species and *Macadamia* (*Helicia*) *ternifolia* possibly belonged to the genus *Brabejum*. *Macadamia ternifolia* is apparently valid, and is accepted in Engler's Pflanzen familien, but *M. verticillata* is identical with *Brabejum stellatifolium*, and the single supposed Australian specimen was evidently taken by Leichardt from a cultivated tree.

ORTHOCARPUS PUSILLUS, Benth. (Scrophulariaceae).

C. L. Forrest, Colac, Nov., 1905; Irrewarra, Nov., 1909. This little weed has been mistaken for a form of *Bartsia latifolia*. It is a native of California, and though apparently not particularly abundant in its native home, has permanently established itself as a naturalized alien in Victoria. Its properties are not known, but it does not at present appear to be a serious weed.

PITHOCARPA CORYMBULOSA, Lindl. (Compositae).

Woorooloo, West Australia.
Max Koch, Jan., 1908. No. 1895.

PITYRODIA (CHLOANTHES) COERULEA (F. v. M. and Tate). Ewart and White. (Verbenaceae).

The unnamed specimens of this plant among the supplements in the National Herbarium had been examined, and were about to be described as a new species, when it was found that they had already been described under *Chloanthus* (Bot. Centralblatt 1893, p. 317). Curiously enough, Mueller neither labelled the type specimens nor inserted the name in the Census, although the species is certainly a valid one. The plant has a pleasant fragrance when rubbed or broken. The stamens are four in number. The seeds are apparently endospermic. The other features are as in the original description under Chloanthus.

New locality, between Upper Blackwood R. and L. Lefroy, 1893. Miss M. Cronin.

TETRATHECA ERICIFOLIA, Sm., var. RUBAEOIDES, A. Cunn. (Tremandreae).

Vereker Range, Wilson's Promontory; Audas and St. John, Oct., 1909. The only recorded locality for this N.S. Wales plant in Victoria it being the fourth peculiar to the National Park.

TRICHINIUM (PTILOTUS) ERIOTRICHUM, W. V. Fitzgerald, MS Ewart and White, n. sp. (Amarantaceae).

Cowcowing, Max Koch, 1904.

Apparently a perennial herbaceous plant, the length of specimens examined being 8-10 inches. Stems slender, wiry, and rather sparsely branching, covered with white felt-like hairs, which are thicker on the younger branches. Leaves ovate-lanceolar, half to one inch long, the under surface somewhat densely villous, and with a fairly prominent midrib. Alternate, shortly petiolate, the internodes being about 1 inch long. Flowers terminal on the end of pedicels of about three-quarters to one and a-half inches in length. Spikes almost hemispherical, flowers sessile. Bracts small, concave, slightly hairy, one to each flower, bracteoles larger, scarious and glabrous, 3 in number. Perianth segments 5, the two outer larger; the scarious margin is blunt, slightly toothed and straw-coloured; outside quite covered over by the long jointed hairs which spring from the lower half of the segments.

The outer segments measure about 1.5 lines, and the hairs 3.0 lines.

Anthers 3, rather long, conspicuously 2-celled, innate; filaments not dilated at the base, united in a cup which is adherent to the perianth tube. Ovary glabrous, style short and simple, stigma capitate.

ROMULEA (TRICHONEMA) CRUCIATA, Ker. Gawl. (Irideae).

Specimens of Onion Grass forwarded to Prof. Beguinot, of Padua, were marked: *Romulea rosea* (L.), Eckl.; var. *parviflora*, Beg.; with *R. parviflora*, Eckl., and *R. rosea*, var. *parviflora*, Baker, as synonyms. In Beguinot's Rivisione delle

"Romulea" (Ann. du Cons. et du Jard., Bot. de Geneve, 1907-1908), pp. 14-15, no variety "parviflora" is recognised under *R. rosea,* but a variety *parviflora,* Beg., is given under *R. cruciata* (Jacq.), Beg. from the Cape of Good Hope. As Beguinot does not mention Baker's *Romulea longifolia,* and gives *Trichonema cruciatum* under *R. cruciata,* var. *vulgaris,* the difficulty still remains unsettled.

Trichonema ochroleuca, Ker. of Benth. Flora, vi., p. 399, is made *Romulea chloroleuca* by Baker, and is classed as a variety *chloroleuca* of *R. rosea* by Beguinot. The Kew Herbarium (Kew Bulletin, 1908, pp. 307-309) does not accept Beguinot's views, and refers our plant to *Romulea Bulbocodium,* Seb. and Maur., with *R. rosea,* Eckl., as a synonym.

Schoenus nitens, Poir., var. major, n. var.

The spikelets are in clusters of up to 20 or more, instead of 2 to 6, and the plants up to 16 inches in height, instead of 1 to 12 inches.

Near Mt. Hunter, National Park, Wilson's Promontory, Audas and St. John, Oct., 1909.

Stylidium Dielsianum, E. Pritzel. Fragm. Phyt. Austr. Occ., p. 596. (Stylideae).

The plant comes near to *S. Merrallii,* F. v. M., the basal or rosetted leaves having white margins, and being minutely apiculate, the labellums in both is small, rounded with two pointed basal appendages, but the gynostemium in *S. Dielsianum* is shorter, the leaves narrower, and the plant has creeping leafless runners. Nevertheless the two species may prove indistinguishable as such when material from varied localities is available.

Thelymitra carnea, R. Br. (Orchideae).

This widely spread species of orchid occurring in South Australia, Tasmania, Victoria and N.S.Wales naturally varies slightly in different habitats, and several forms have been described as distinct species. Thus:—

T. Elizabethae, F. v. M., in Vict. Nat., vol. vii., p. 116, 1890, differs from T. carnea merely in trifling differences of colour, and in its somewhat smaller size. Its only locality is near Camberwell, Nov., 1890, and Sept., Oct., 1900.

T. rubra, Fitz., in Gard. Chron., 1882, i., p. 495.

Mount Lofty, S. Australia, Oct., 1881; Blackwood, S. Australia, October, 1906, R. S. Rogers.

This is stated to differ from *T. carnea* in its flowers opening, while those of *T. carnea* are supposed always to remain closed, which is not correct.

T. Mackibbinii, F. v. M., in Melb. Chemist, xl., 1881

Upper Loddon, R. J. Mackibbin, Sept., 1881; Smythe's Creek, C. Collyer, Nov., 1883. In Mueller's Census it is given as from W. Australia, S. Australia and Victoria. The Herbarium contains Victorian specimens only, but Mueller considered *T. rubra* to be identical with his species, and therefore extended the locality. It is doubtful whether any of these forms extend to W. Australia.

All are undoubtedly forms of *T. carnea*, and the specific names synonyms to that species.

EXPLANATION OF PLATES.

Plate LVI.

Fig. 1.—Angianthus axiliflorus, Ewart and White. Plant (slightly magnified).

2.—One-flowered partial head (magnified).

3.—Single flower (magnified).

Plate LVII.

Fig. 1.—Calocephalus Skeatsiana, Ewart and White. Plant (about natural size).

2.—Leaf (enlarged).

3.—Bract from one of the partial heads (enlarged).

4.—Single flower (enlarged).

Plate LVIII.

Fig. 1.—Inner bract of partial head of Calocephalus Knappii.
2.—Outer " " " " "
3.—Inner " " " " multiflorus.
4.—Outer " " " " "
5.—Inner " " " " Skeatsiana
6.—Outer " " " " "
7.—Inner " " Eriochlamys Behrii.
8.—Outer " " " " "
9.—Flower of Calocephalus Knappii.

Plate LIX.

Fig. 1.—Halgania tomentosa, Ewart and White. Part of flowering branch (natural size).
2.—Fruit (natural size).
3.—Transverse section of leaf (greatly magnified).
4.—Part of flowering branch of Pityrodia coerulea (F. v. M. and Tate), Ewart and White. (Natural size.)
5.—One of the 4 divisions of the fruit of Pityrodia coerulea, (enlarged).

Plate LX.

Fig. 1.—Portion of flowering branch, *Trichinium eriotrichum.*
2.—Outer bract.
3.—Bracteole.
4.—Perianth segment with a stamen attached to the staminal ring.

Introduced Exotics not yet sufficiently established to be considerld naturalised.

Calycotome spinosa, Link. (Leguminosae). "Prickly Broom."

A native of South-west Europe.

Growing along roads at Bolwarrah, near Ballarat, July, 1909, C. French, junr.

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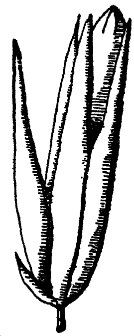

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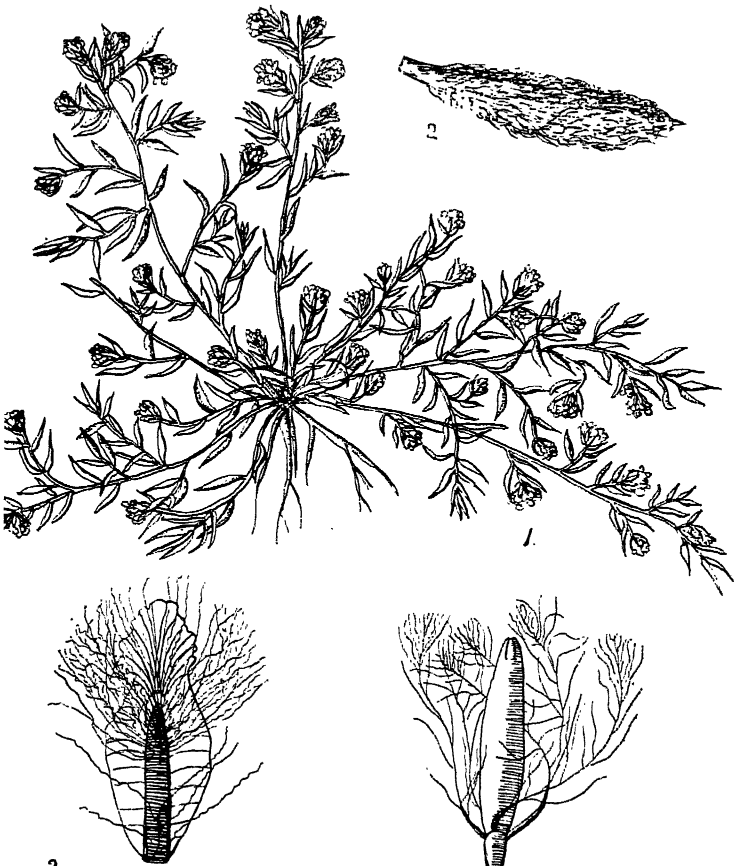
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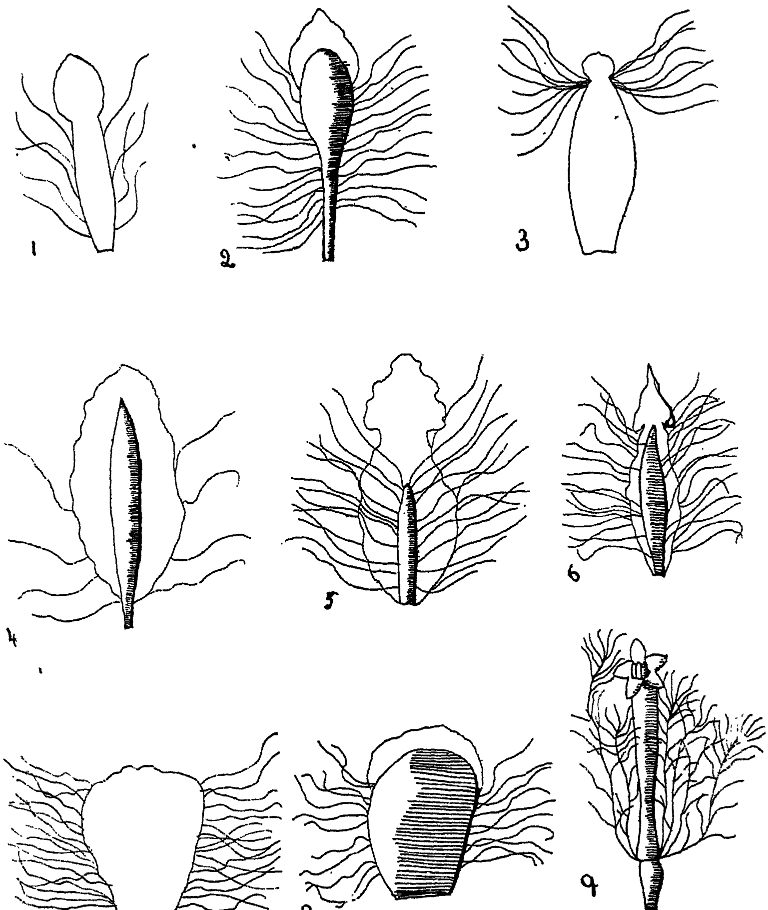
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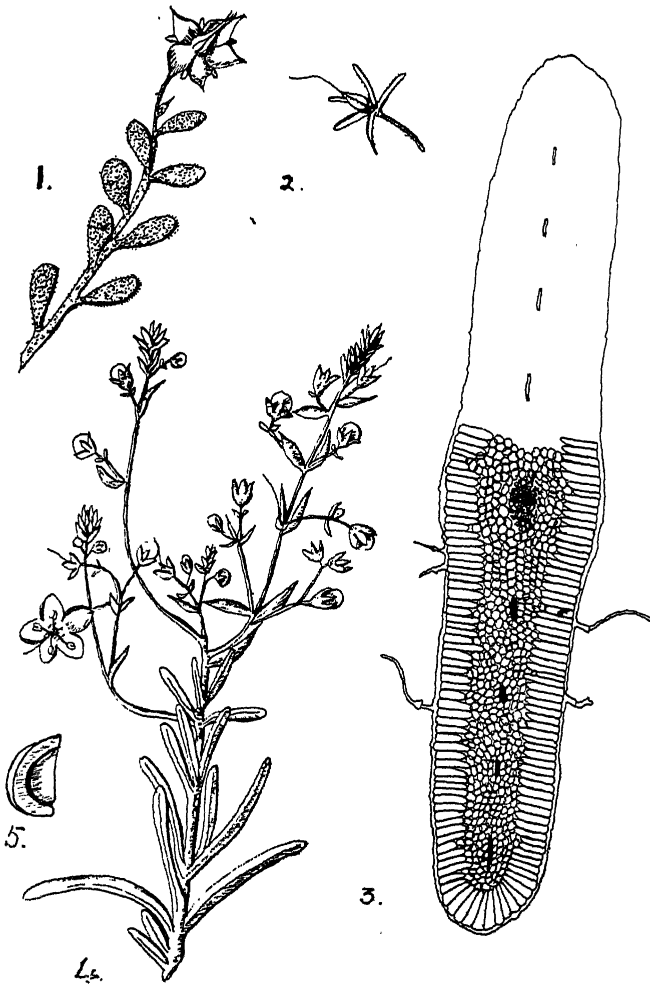
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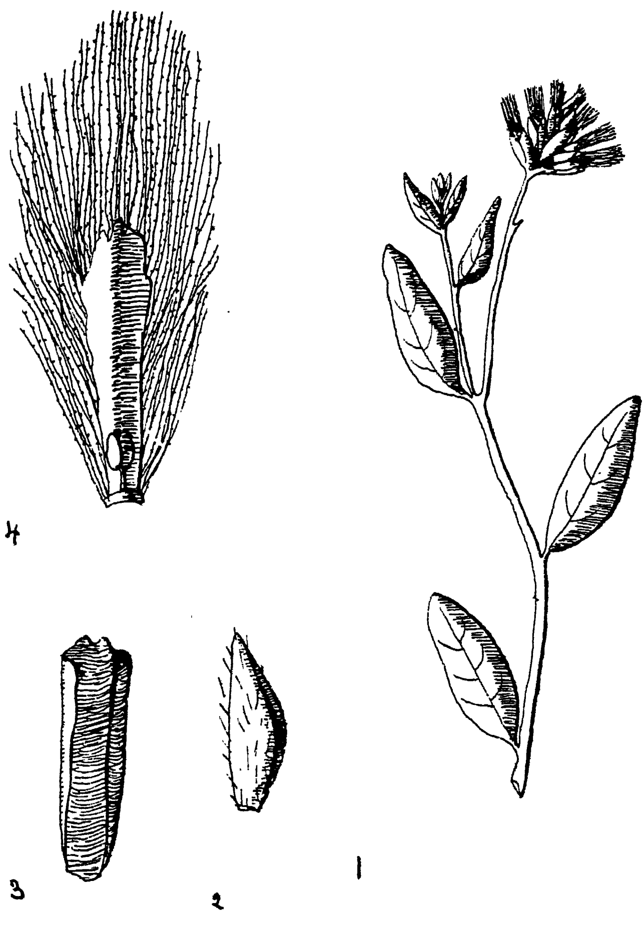
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PASCALIA GLAUCA, Orteg. (Compositae).

A native of Chili.

Verified at Kew. Railway Reserve, North Melbourne, March 1909, J. R. Tovey and C. French, junr.

ADDITIONAL LOCALITIES FOR NATURALISED ALIENS.

LYCHNIS DIOICA, L., var. ALBA.

Wodonga, W. Burvill, October, 1909. Previously recorded from East Victoria.

TRIGONELLA ORNITHOPOIDES, L.

Seymour, Mrs. F. M. Reader, Nov., 1902.
In Reader's Herbarium under *Trifolium subterraneum*, L.
Yarram, Gippsland, S. Perm, Oct., 1909.
Previously recorded from the South-west of Victoria.

[PROC. ROY. SOC. VICTORIA, 22 (N.S.), PT. II., 1909]

ART. XXII.—*Notes on the Wombat, Phascolomys ursinus, Shaw, from Flinders Island.*

BY J. A. KERSHAW, F.E.S.

Curator of the Zoological Collections, National Museum, Melbourne.

(With Plate LXI.).

[Read 9th December, 1909].

During the latter part of the 18th century, Wombats were known to exist plentifully on many of the islands in Bass Strait. The earliest recorded example of the genus was that captured on Clarke Island in 1797, during an expedition sent from Sydney, New South Wales, to rescue the crew of the *Sydney Cove*, wrecked between Preservation and Rum Islands, off the south-west coast of Flinders Island. This was brought back to New South Wales, where it lived in captivity for six weeks, its body being sent to England during the same year by Hunter, then Governor of New South Wales.

Although there is every reason to believe that the mainland species (*Phascolomys mitchelli*, Owen) was well known to the early settlers prior to the discovery of the island species, it is strange that no specimens appear to have been sent from New South Wales, at any rate, until many years later.

Flinders was evidently acquainted with the New South Wales species prior to the discovery of the island form, for, in referring to that found on Clarke Island, he says[1] "The little bear-like quadruped is known in New South Wales, and called by the natives Womat, Wombat, or Wombach."

In addition to Clarke Island, this animal occurred plentifully on Cape Barren and the Furneaux Islands on the eastern side, and King Island on the western side of the Strait, and was

1 Flinders. Voyage to Terra Australis, 1814, vol. i., Introduction, p. cxxxv.

repeatedly mentioned in the accounts of the early expeditions by Bass, Flinders, Péron, and others. Flinders[1] also states that "Preservation and the Passage Isles do not possess it."

Unfortunately these animals have been exterminated from all the islands they were known to inhabit, with the sole exception, so far as I have been able to ascertain, of Flinders, the largest of the group on the eastern side of the Strait.

The material obtained by the National Museum, which has recently been dealt with by Professor Spencer and myself in two separate papers,[2] and in which a full account of the literature on the subject is given, proves that these animals also existed on Deal Island in the Kent Group, and Kangaroo Island on the west of Flinders. It is also very probable that they occured about the same time on several of the adjacent islands, both on the east and west sides of the Strait.

During two separate visits to the Bass Strait islands, undertaken at the suggestion of Professor Spencer, Director of the Museum, with the object of finding if the Wombat still existed there, I was fortunate in discovering it still living on Flinders Island, and brought back two skins and an incomplete skeleton.[3] Unfortunately, owing to the limited time available and the rough nature of the country inhabited by them, I was not successful in obtaining a living specimen, and could only make arrangements to have the first one captured sent to Melbourne. Their burrows are usually constructed under the huge granite boulders and extend for some distance. Exhaustive enquiries among the half-castes and settlers on the islands, and the fishermen visiting there, failed to reveal any evidence of its existence at the present time on any of the adjacent islands.

However, through the courtesy of Dr. J. W. Barrett, with whom I visited the islands, and who kindly interested himself in the matter, a living specimen captured on the northern end of Flinders was received by the Museum on the 28th of October last. This proved to be a female, and, as I found later, was carrying a fairly-developed young one in the pouch.

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1 Ibid.
2 Memoirs of the Nat. Museum, No. 3, Feb., 1910.
3 See " " " " " p. 47.

Although inclined to be savage for the first few days, she soon became accustomed to my presence and took the food offered, consisting of fresh grass and thistles, very readily. By gentle treatment she gradually permitted me to handle her, and seemed particularly fond of being rubbed along the back, head and sides. I found that by rubbing her along the sides, behind the foreleg, she almost invariably tumbled over lazily on her side; in fact she seemed unable to resist the inclination to do so. By continuing the rubbing process between the forelegs and under the jaws, she would gradually settle herself more comfortably, and allow both fore and hind feet to be gently handled.

It was during such an operation that I discovered the presence of the young one in the pouch, and noticed it was attached to the teat and had the eyes closed. Any sudden movement or slight noise would cause her to immediately start up and huddle herself in a corner of her enclosure, uttering a low growl and kicking violently backwards with both hind legs at once.

On the 10th November, or 14 days after her arrival, it was noticed that the young one, though still in the pouch, was not attached to the nipple and had its eyes open. It would occasionally extend one or both fore feet from the pouch as though stretching itself. The following day it was found crawling about in an apparently very weak state, close by the mother. The latter appeared to be very uneasy, and attempted to push it under her body with her paws. Every care was taken to prevent her being disturbed, but when visited later in the day the young one was lying near her, cold and almost dead. No sooner had I picked it up than the old one rushed at me savagely and, failing to reach me, bit pieces from the edge of the box on which I stood.

I eventually succeeded in soothing her, and after a time she permitted me to expand the pouch, which seemed to have contracted very much, sufficiently to insert the young one. My efforts were, however, useless, for, apparently owing to her quick movements, the young one was again ejected, and was found quite dead the same evening.

A second living specimen, captured near Killiecrankie, on the north-west side of Flinders Island, was received on 20th January last. This was also a female and not full-grown. It arrived in

very poor condition, and although taking its food readily, it did not thrive, and unfortunately died on 15th February. It was a particularly tame and gentle creature and could be handled with impunity.

In habits these animals remind one of the Rodents, their manner of feeding and quick side-to-side movement of the jaws being very similar. They are very quick in their movements when excited or alarmed, and run with greater speed than one would expect from such an apparently awkward animal. When touched, especially near the hind quarters, they have a peculiar habit of kicking violently backward with both hind feet. This, it was noticed, occurred even when approached by its companion. If annoyed, they do not hesitate to use both teeth and claws.

A peculiarity not before noticed is their habit of using the fore feet for grasping, closing the claws on to the roughened under-surface of the paw to such an extent that small objects such as grass leaves can easily be seized. When feeding they repeatedly grasp and wrench off with one of the paws pieces of grass stems protruding from the mouth, or separate the clumps of long grass in order to obtain some specially-desired portion. They are particularly partial to the fresh green seed stems, and invariably select these first.

In confinement these specimens drank very little water, even in the hottest weather, and only once was one of them actually seen in the act. They spent most of the day sleeping, partly buried in their bedding, but would take feed at any time.

The first specimen received is evidently full-grown and in excellent condition. Compared with the Tasmanian species (*Phascolomys tasmaniensis*)[1] it appears somewhat smaller. The hair is fairly soft to the touch, not coarse as in *P. mitchelli*, nor so silky as *P. latifrons*. Colour grizzled-grey, slightly darker on the hind quarters, lighter on head and neck. Underside of jaws, neck and body, inner side of limbs, and interior of ears, dirty white. Underfur fairly abundant, particularly on the neck, shoulders and sides, varying in colour from brown on the back to dark greyish on the sides. Eyes dark reddish-brown.

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1 Memoirs of Nat. Museum, No. 3, Feb., 1910, p. 57.

Two teats situated just within the opening of the pouch.

The second specimen is immature Colour, dark grizzled-grey, lighter on front of head, limbs, and underside. The hairs of the back and sides, when closely examined, are dark brown, almost black at their extreme tips, and conspicuously ringed with white towards their distal end. Shoulders and along centre of back blackish, due to the abundant long, projecting, coarser hairs. Underfur fairly thick, dark brown. Sides of muzzle and feet dark brown. Ears well haired, with a dark-brown patch behind, inner sides whitish.

Dimensions :—

Head and body - - - -	650 mm.
Hind foot - - - - -	73 mm.
Ear - - - - - -	60 mm.
Tail from anus - - - -	50 mm.
Protruding portion of tail - -	24 mm.

Dimensions of young female :—

Head and body - - - -	255 mm.
Hind foot - - - - -	24 mm.
Ear - - - - - -	12 mm.
Tail - - - - - -	10 mm.

From evidence obtained at the time of, and since, my visit to the islands, this species appears to vary in colour to the same extent as the Tasmanian and Australian species, black or nearly black varieties being occasionally met with.

Phascolomys ursinus, Shaw.

ANNUAL REPORT OF THE COUNCIL

FOR THE YEAR, 1908.

The Council herewith presents to Members of the Society the Annual Report and Details of Receipts and Expenditure for the year 1908.

The following meetings were held :—

March 12th—Annual Meeting and Election of Officers. At the close of the Annual Meeting an Ordinary Meeting was held. Papers read: 1. "On the longevity of Seeds," by Prof. A. J. Ewart, with an Appendix by Miss Jean White, M.Sc. 2. "The Geology of the Whittlesea District," by J. T. Jutson, with an Appendix on the fossils by F. Chapman. 3. "The anatomy of Ibla quadrivalvis," by Miss F. Bage, M.Sc. Exhibits: Mr. F. Chapman exhibited specimens in illustration of his remarks.

April 9th—Papers read: 1. "The Cherts and diabase rocks of Tatong," by H. St. J. Summers. 2. "Further descriptions of the Tertiary Polyzoa of Victoria," by C. M. Maplestone. Exhibits: Prof. Skeats showed slates and sandstones from Nowa Nowa, which had been partly or entirely replaced by hematite.

May 14th—Papers read: 1. "Notes on an abnormal development of leaves of Prunus cerasus," by Miss Bertha Rees. 2. "Notes on the Dolodrook Serpentine area and the rhyolites of Mt. Wellington, North Gippsland," by E. O. Thiele, B.Sc. Exhibits: Prof. Skeats showed Keryite from Mt. Erebus, collected by Prof. T. W. E. David. Mr. Thiele showed rock specimens and photographs in illustration of his paper.

June 11th—Papers read: 1. "The Graptolite beds at Daylesford," by T. S. Hart, M.A., F.G.S. 2. "The Geology of the proposed Nillahcootie water conservation area," by H. St. J. Summers. 3. "On the evidence of the origin, age and alteration of the rocks near Heathcote," by Prof. E. W. Skeats.

July 9th—Special Meeting to consider a proposed alteration of the rules, proposed by Prof. Ewart. Rule xxii. was amended by

substituting the words "half-past nine" for the word "ten." The proposal to institute a new rule to allot the time required for the reading of papers was rejected. At the close of the Special Meeting, an Ordinary Meeting was held. Papers read: 1. Variations in the anatomy of Hyla aurea," by Dr. Georgina Sweet. 2. "On some new species of Victorian Mollusca," by J. H. Gatliff and C. J. Gabriel. 3. "Additions to and revision of the Catalogue of Victorian Marine Mollusca," by the same authors 4. "On the occurrence of the genus Linthia in Victoria, with the description of a new species," by G. B. Pritchard, B.Sc., F.G.S. Exhibits: J. H. Harvey showed stereoscopic views of portions of the most recently opened up Jenolan caves. G. B. Pritchard showed specimens of Linthia from the Victorian older Tertiary. T. S. Hall showed Linthia australis, from Cowes.

August 13th.—Prof. R. J. A. Berry delivered a lecture, "Fashion in deformity," The lecture was illustrated by a large series of lantern slides.

September 10th.—Papers read: 1. "Description of a new species of Peripatoides from Western Australia," by Prof. W. Baldwin Spencer, M.A., C.M.G. 2. "On the structure of Hologlœa dubia, an organism of doubtful affinity," by the same author. 3. "Polyzoa from the Gilbert Islands," by C. M. Maplestone. Exhibits: J. A. Kershaw exhibited Denisonia nigrescens, from Ringwood—a snake new for Victoria.

October 8th—Papers read: 1. "Obsidianites: Their origin from a chemical standpoint," by H. S. Summers, M.Sc. 2. "Obsidianites: "Their origin from a physical standpoint," by Kerr Grant, M.Sc. Exhibits: Obsidianites, by the two authors on behalf of numerous owners, and by R. H. Walcott on behalf of the trustees of the National Museum.

November 12th—Paper read: "Some bodies resembling Obsidianites," by D. J. Mahony, M.Sc. An adjourned discussion on Obsidianites then took place. Exhibits: D. J. Mahony showed specimens illustrating his paper, and F. Chapman did the same; E. J. Dunn and R. H. Walcott showed Obsidianites.

December 10th—Papers read: 1. "Description of a new species of Sminthopsis," by Professor Baldwin Spencer. 2. "On the occurrence of the selachian genus Corax in the lower cretac-

eous of Queensland," by F. Chapman, A.L.S. 3. "Endoparasites of Australian Stock and Native Fauna, Pt. I., Census," by Dr. Georgina Sweet. 4. The same, "Pt. II., New and unrecorded species," by the same author. 5. "On the separation and analysis of minerals in the dacite of Mount Dandenong, Victoria," by H. C. Richards, B.Sc. 6. "Contributions to the Flora of Australia, No. 10, by Prof. A. J. Ewart and Miss Jean White, M.Sc.

During the year five members and nine associates have been elected, one member and two associates have died, four associates have resigned, and the names of eight associates have been removed from the register.

Alfred William Howitt, C.M.G., D.Sc., F.G.S., died in March, 1908, having been a member for thirty years. Dr. Howitt first came into public notice as the rescuer of King, the survivor of the Burke and Wills' expedition. He became a police magistrate and warden of the goldfields, and in these capacities he thoroughly explored the mountains of Gippsland. He had a deep knowledge of the timber trees of Gippsland. and wrote an important paper on the eucalypts. He geologically surveyed and mapped the country to the north of Bairnsdale, and worked out the history of the Devonian rocks of eastern Victoria. As a petrologist he was a pioneer in the days when the subject was but little studied, and he prepared his own slices and made his own rock analyses. It is probably as a geologist that he is best known in Australia, but elsewhere he was best appreciated as an ethnologist, and numerous honours were conferred on him, including the first award of the Müeller medal. A fund has been founded to perpetuate his memory by a medal to be awarded for valuable scientific work.

T. B. Muntz, C.E., joined the Society in 1873. He was well known as a municipal engineer and as the contractor for the Coode canal. Although he rarely attended our meetings he took a keen interest in general science, and was a loyal supporter of the Society.

It has been decided, as far as possible, to obtain portraits of all past presidents, to be hung in the library, and several have already been received.

The long-continued efforts to secure the reservation of Wilson's Promontary as a National Park and Sanctuary for native flora and fauna have been crowned with success, and 100,000 acres have been permanently set apart and placed under a Committee of Management, consisting chiefly of representatives of the various bodies interested, and public opinion seems to have been roused. A committee to advise the Government on matters concerned with the native flora and fauna was constituted by several societies, including this Society. The Government consented to consult the committee as occasion might arise, and has already done so on several occasions.

A committee of the Council considered the question of increasing the accommodation in the Society's building, and especially of providing space for larger meetings. Want of funds prevented anything being done.

During the year the caretaker's cottage has been renovated, the fence has been repaired thoroughly, a hedge has been planted, and the grounds generally have been put in order as far as funds would allow.

A new bookcase has been placed in the lecture room, as the library is full, and storage shelving has been furnished in the lower room.

The Council agreed to defray the cost of stationery and postage incurred in the compilation of a new edition of the Catalogue of Scientific and Technical periodicals in Melbourne. The work is well advanced, and the new edition promises to contain about double the number of entries that the previous one did.

The death of Mr. Ellery reduced the number of Trustees to two, and at the request of the Society, the Chief Secretary, the Hon. J. E. Mackey, consented to the appointment of Professor W. Baldwin Spencer and Mr. P. Baracchi to fill the vacancies caused by the death of Mr. Ellery and of Sir W. F. Stawell, the latter of whom died many years ago. The appointments were duly gazetted.

Professor W. Baldwin Spencer subsequently resigned his seat on the Council owing to the increased pressure of his other public duties. Professor Spencer was Secretary of the Society from 1889 to 1899, and had a seat on the Council from 1888 to the

present year. The present position of the Society is largely due to his energy and sound judgment. His resignation was accepted with great regret, but it was felt that as a trustee his help could always be counted on when required.

The Hon. Librarian reports that during the year 1908 the additions to the Library numbered 1511.

No binding was done during the year, and a hope is expressed that provision may be made this year for this purpose.

The Honorary Treasurer in Account with the Royal Society of Victoria.

Dr.	£	s.	d.	Cr.	£	s.	d.
To Balance from 1907	£108	11	5	By Printing	£235	13	2
Government Grant	100	0	0	Postages and Petty Cash	30	5	0
Subscriptions—				Assistant-Secretary	25	0	0
Members	26	5	6	Hall Keeper	6	0	0
Associates	15	15	0	Rates	4	6	8
Arrears	16	16	0	Insurance	5	1	3
Advance Payments	3	3	0	Collector's Commission	13	1	11
Subscriptions collected by Collector ...	99	16	0	Gas	4	18	0
Rent	57	15	0	Refreshments and Cleaning	7	4	11
Sale of Publications	31	8	0	New Crockery, &c.	1	13	0
				Periodicals	4	4	0
				Illustrating Journal	21	11	0
				Lantern	0	17	6
				Repairs	29	12	4
				New Bookcase	32	17	6
				Trustees' Fees	2	2	0
				Bank Charge	0	10	0
				Balance in Bank	34	11	8
	£459	9	11		£459	9	11

Compared with the Vouchers, Bank Pass-Book, and Cash-Book, and found correct,

(Signed) J. SHEPHARD, *Hon. Treasurer.*

(Signed) JAMES E. GILBERT, JAS. ALEX. SMITH, } *Auditors.*

4th March, 1909.

ANNUAL REPORT OF THE COUNCIL

FOR THE YEAR, 1909.

The Council herewith presents to Members of the Society the Annual Report and Details of Receipts and Expenditure for the year 1909.

The following Meetings were held :—

March 4th.—Annual Meeting and Election of Officers. At the close of the Annual Meeting an Ordinary Meeting was held. Papers read: 1. "Preliminary Communication on Fifty-three Tasmanian Crania, Forty-two of which are recorded for the first time," by Professor R. J. A. Berry, M.D., F.R.S.E., and A. W. D. Robertson, M.B., B.S. Exhibits: Mr. F. Chapman exhibited a large example of *Cypraea sphaerodoma*, Tate (146 mm. long), from the Tertiary of Muddy Creek, and Corals, *Placotrochus deltoideus*, Duncan, from the Tertiary of Balcombes Bay, collected by R. H. Annear; also on behalf of the National Museum a collection of Fossil Corals showing method of growth.

April 15th.—Paper read: "On a new species of Leperditia from the Silurian of Yass, New South Wales," by F. Chapman, A.L.S. Exhibits: Professor E. W. Skeats showed a collection of Mineral and Rock specimens from Kangaroo Island, S. Australia, and Mt. Morgan, Queensland.

May 13th.—Papers read: 1. "Contributions to the Flora of Australia, No. 11," by Professor A. J. Ewart, D.Sc., Ph.D., Dr. Jean White, and Miss Bertha Rees; with Appendices by J. R. Tovey and J. W. Audas. 2. "Descriptions of Two Terrestrial Species of Talitridae from Victoria," by O. A. Sayce. Exhibits: Professor E. W. Skeats exhibited two remarkable examples of Ropy Basalt. Mr. A. D. Hardy showed specimens of *Casuarina distyla* showing monoecious habit and Freshwater Alga (*Tetmemorus brevissoni*) showing zygospore.

June 10th.—Papers read: 1. "Description of a new Marine Shell of the genus Larina," by J. H. Gatliff and C. J. Gabriel. 2. "Additions to the Catalogue of the Marine Shells of Victoria,"

by the same authors. Exhibits: 1. Dr. T. S. Hall showed an Obsidianite from Mortlake, Victoria. 2. Mr. F. Chapman exhibited a fossil fish from Mansfield, Victoria. 3. Professor Skeats exhibited a series of rock specimens from Macedon district.

July 8th.—Papers read: 1. "The Structure of the Blood-vessels of Australian Earthworms, Part I.," by Miss Gwynneth Buchanan, B.Sc. 2. "Notes on the Structure of Asymmetron bassanum, Günth.," by Mrs. Ethel Remfrey Morris, M.Sc., and Miss Janet Raff, B.Sc. 3. "Contributions to the Flora of Australia, No. 12," by Professor Ewart, D.Sc., Ph.D., and Dr. Jean White. Exhibits: 1. Mr. P. Baracchi exhibited and explained an interesting series of Astronomical slides, illustrated by the lantern. 2. Professor Baldwin Spencer exhibited a number of sub-fossil remains of a small extinct Emu (*Dromaeus minor*, Spencer) from King Island, Bass Strait, and gave an interesting description of their occurrence on parts of King Island and of an allied species from Kangaroo Island, South Australia, pointing out the chief characters which separate them from the existing mainland species. 3. J. A. Kershaw showed, on behalf of the National Museum, albino and melanistic varieties of the Rufous-bellied Wallaby (*Macropus billardieri*), both from Tasmania, and a normally coloured specimen of the same species from Victoria. A number of specimens were also shown in illustration of the papers read.

August 12th.—Professor J. A. Gilruth delivered a lecture entitled "Stock Diseases in Victoria and Tasmania." Exhibits: 1. Professor Baldwin Spencer exhibited a pair of Aboriginal Kurdaitcha shoes from Central Australia. 2. Dr. Hall showed photographs of rocks showing ripple markings, and of a Virginian Creeper, illustrating extraordinary growth. 3. Mr. Baracchi exhibited and described a series of photographs of notable Comets.

September 9th—Papers read: 1. "New or little-known Victorian Fossils in the National Museum, Part X.—Some Palaeozoic Worms and Crustacea," by F. Chapman, A.L.S. 2. "Australian and Tasmanian Coleoptera, with descriptions of new species, Part I.," by Arthur M. Lea, F.E.S. Exhibits: 1. Professor R. J. A. Berry exhibited specimens in illustration of a

new method, introduced by him, of mounting and preserving objects in glycerine jelly. 2. F. Chapman showed specimens and diagrams in illustration of his paper. 3. H. C. Richards showed a Volcanic Bomb from Tower Hill, near Koroit, Victoria. 4. J. A. Kershaw exhibited a series of beetles of the genus *Lamprima* from Queensland, New South Wales and Victoria.

October 14th.—The following series of demonstrations, arranged by Professor R. J. A. Berry, were given at the Anatomy Department, Melbourne University:—1. Professor Berry gave a lantern demonstration on "Sectional Anatomy by Clinical Methods," and "The Sectional Anatomy of the head of the Australian Aboriginal." 2. Dr. J. H. Anderson, on "The Estimation of the Cubic Capacity of the Skull, and the Correlation of the size of the head to intellect." 3. Dr. A. W. D. Robertson, on "The relative Racial Relationship of the Tasmanian, Australian, and Papuan, as estimated from a study of the correlations and variabilities of their Crania." 4. Mr. R. O. Douglas, on "The apparent decadent position in Evolution of the Australian Aboriginal, as estimated from a study of the Osteometry of the Femur, illustrated by the prehistoric femora of Spy, Cromagnon and Tilbury." An inspection of the Anthropological and Anatomical specimens in the museum followed.

November 11th.—Papers read: 1. "Notes on the Physical History of the Plenty River and Anderson's Creek, Warrandyte," by J. T. Jutson. 2. "The place in nature of the Tasmanian Aboriginal: his relationship to the Anthropoid Ape, Primitive and Modern Man," by Professor R. J. A. Berry M.D., F.R.S.E., and A. W. D. Robertson, M.B., Ch.B. These papers were illustrated by large series of lantern slides.

December 9th—Papers read: 1. "Building Stones of Victoria, Part I.—Sandstones," by H. C. Richards, M.Sc. 2. "The Structure of the Truncus Arteriosus in species of the genera Hyla, Limnodynastes, Chiroleptes, Helioporus, Pseudophryne and Notaden," by Miss Kathleen K. Oliver. 3. "Contributions to our knowledge of Australian Earthworms—the Bloodvessels, Part II.," by Miss Gwynneth Buchanan, B.Sc. 4. "Note on the Structure of the Accessory Glands of Cryptodrilus saccarius," by Miss Gwynneth Buchanan, B.Sc. 5. "Contributions to our knowledge of Australian Earthworms—the Nephridia," by Miss

Freda Bage, M.Sc. 6. "Contributions to our knowledge of Australian Earthworms—the Alimentary Canal, Part I," by Miss Janet W. Raff, B.Sc. 7. "On the Bacchus Marsh Sandstones and their Fossils," by G. B. Pritchard, B.Sc., F.G.S. 8. "A Study of the Batesford Limestone," by F. Chapman, A.L.S. 9. "Contributions to the Flora of Australia, No. 13," by Professor A. J. Ewart, D.Sc., Ph.D., and Dr. Jean White. 10. "Notes on the Wombat, Phascolomys ursinus, Shaw, from Flinders Island, Bass Strait," by J. A. Kershaw, F.E.S.

During the year three members, four associates and one country member have been elected, two honorary and three ordinary members and one associate have died, and four members and five associates have resigned.

William Charles Kernot, M.A., M.C.E., F.R.G.S., was born at Rochford, Essex, England, and was brought to Victoria by his parents at the age of 6. He was educated at the National Grammar School, Geelong, and at Melbourne University. From 1865 to 1875 he was on the staff of the Mining and the Water Supply Departments. Subsequently he became first Professor of Engineering at Melbourne University and held the post for 26 years till his death on 14th March, 1909, at the age of 63. He served on many juries in connection with International Exhibitions, was frequently consulted by the Government on engineering questions, and was in constant request as an expert in law cases. He joined the Society in 1870, and was President from 1885 to 1900 and a member of Council till his death. He was the author of several papers published in our Proceedings, but most of his work, being of an engineering character, appeared elsewhere. He took an active interest in the Royal Geographical Society (Victorian branch) and in the Institute of Engineers, of which bodies he was several times President. He was a large benefactor to the Working Men's College and the University, and his minor gifts to various scientific societies and institutions, including our own, were very numerous. His kindly nature, which never allowed him to speak ill of anyone, and the breadth of his interests, endeared him to everyone, and he passed away regretted by all who knew him.

Georg Balthasar von Neumayer, Ph.D., F.R.S., &c., died on 24th May, 1909, at Neustadt, Bavaria, in his 83rd year. He

was for many years Director of the Deutsche Seewarte, Hamburg. In 1857, with the assistance of Maximilian, King of Bavaria, and Alexander von Humboldt, he founded the Flagstaff Magnetical and Meteorological Observatory in the Flagstaff Gardens, Melbourne. This he managed for nearly seven years, and during this time he made a magnetic survey of the country up to the foot of Mt. Kosciusko. Six years were then spent in preparing his results for publication, and they appeared in two large volumes. Neumayer was the recipient of honours from all over the civilized world and was elected an honorary member of our Society in 1855.

Sir Charles Todd, K.C.M.G., F.R.S., for many years Deputy Postmaster-General of South Australia, was elected an Honorary Member in 1856. His great work was the establishment of the Overland Telegraph from Adelaide to Port Darwin.

We have also to record the death of Dr. E. B. Heffernan, M.D., B.S., and A. L. Mills, members of the Society, and R. J. Larking, an Associate, all of whom were long supporters of the Society, but took no active part in its administration.

The following publications were issued during the year: "Proceedings," Vol. XXI., Pt. 2; and Vol. XXII., Pt. 1.

During the year the Council found it necessary to approach the Government as a deputation with a request for a special grant to permit of the publication of a large series of plates in illustration of the paper contributed by Professor R. J. A. Berry and Dr. A. W. D. Robertson on Fifty-three Tasmanian Crania, read before the Society in March last. The Chief Secretary, the Hon. J. Murray, and the Treasurer, the Hon. W. A. Watt, to whom the request was made, met the Council very generously, and undertook to have the work done by the Government Printer, under the Council's supervision. The publication, which will be issued as Vol. V., Pt. 1, of the Transactions, is practically finished, and should be available for distribution early in the present month.

The Council decided to instal electric light throughout the building in place of gas. The work has been completed during the recess, and the effect is a decided improvement. Special attention was given to the lighting of the library, which is provided with two 100 c.p. lamps. A special reading lamp is also provided

for use during lantern demonstrations. The total cost of the work amounted to £22.

The islands adjacent to Wilson's Promontory, known as Shellback, Norman, Anser, Wattle and Rabbit Islands, together with those in Corner Inlet, known as Doughboy, Granite and Bennison Islands, have recently been permanently reserved, and, it is expected, will shortly be placed under the control of the Committee of Management of the National Park. These islands, most of which are important breeding places for many species of native birds, will add about 730 acres to the 100,000 already reserved on the Promontory. The Government has set apart £1000 for the erection of a substantial vermin-proof fence across the north-west corner of the Promontory, and tenders are now being called for the work. Plans are also being drawn up for the erection of a house near the Darby River, which will include accommodation for the Ranger, and its erection should be shortly proceeded with.

Several young Emus, Satin Bower-Birds, and a young Lyre-bird, have been introduced into the Park, and arrangements are in progress to secure Wombats and Kangaroos, which are not yet represented there.

The Committee formed to advise the Government in connection with the Fisheries and Game Acts, on which this Society is represented, has continued to be consulted on all matters relating to the preservation of the native fauna. Several recommendations made have been adopted, and the Committee has approved of a proposal, now under consideration by the Government, to make the close season for the majority of the native birds uniform. A list of birds, at present only partially protected, has been drawn up and submitted to the Government, with a view to their total protection.

The number of Trustees has been reduced to three owing to the death of Professor W. C. Kernot.

The Hon. Librarian reports that during the year a number of books were bound, and most of the Australian publications in the library are now bound to date.

The provision of a new book case has given sufficient shelf room to allow for the additions for several years.

Royal Society of Victoria in Account with the Honorary Treasurer.

RECEIPTS.

Mar. 1909.		
To Balance from 1908/9		£34 11 8
Sales of Publications—		
To State Government ...	£15 0 0	
To Public	3 16 5	
		18 16 5
Government Grant		200 0 0
Rents		57 0 0
Subscriptions—		
Members, 1909	£86 2 0	
Arrears	14 14 0	
Associates, 1909	51 9 0	
Arrears	11 11 0	
1910	2 2 0	
Country Members ...	12 12 6	
		178 10 6
		£488 18 7

EXPENDITURE.

By Library—Perodicals	£6 10 2	
Binding	9 10 0	
		£16 0 2
Publication—Printing ...	£147 13 6	
Postage, &c.	20 10 0	
		168 3 6
Maintainance—		
Clerk	£25 0 0	
Caretaker's A/cs.	14 7 2	
Insurance	5 1 3	
Repairs	4 6 6	
Rates	7 9 7	
Gas	2 19 0	
Lanternist	1 15 0	
		60 18 6
Finance Charges—		
Commission	£13 2 11	
Bank Charge	0 10 0	
Impressed Stamps for Cheques	1 0 0	
		14 2 11
Sundries—		
Petty Cash, Hon. Treas. ...	£1 0 0	
" " Hon. Sec. ...	1 0 0	
Wreath for Prof. Kernot's Funeral	1 1 0	
		3 1 0
Balance to 1910/11		226 2 6
		£488 18 7

Compared with the Vouchers, Cash-Book, and Bank Pass-Book, and found correct,

WM. A. HARTNELL,
Hon. Treasurer.

(Signed)
25/2/10.

JAMES E. GILBERT, } *Auditors.*
JAS. ALEX SMITH, }

Royal Society of Victoria.

1909.

Patron:

SIR THOMAS GIBSON CARMICHAEL, BART.

President:

P. BARACCHI, F.R.A.S.

Vice-Presidents:

PROF. E W. SKEATS, D.Sc., A.R.C.S.
PROF. R. J. A. BERRY, M.D., F.R.S.E.

Hon Treasurer:

W. A. HARTNELL.

Hon. Librarian:

R. D. BOYS, B.A.

Hon. Secretary:

J. A. KERSHAW, F.E.S.

Council:

E. J. DUNN, F.G.S.
PROF. A. J. EWART, D.Sc., Ph.D.
P. de J. GRUT.
T. S. HALL, M.A., D.Sc.
J. JAMIESON, M.D.
C. E. OLIVER, M.C.E.
J. SHEPHARD.
G. SWEET, F.G.S.
R. H. WALCOTT, F.G.S.
E. J. WHITE, F.R.A.S.
F. WISEWOULD.
H. A. HUNT, *succeeded by*
Hon. G. SWINBURNE, M.L.A.

Committees of the Council:

House Committee:

THE HON. TREASURER (CONVENER).
P. DE J. GRUT.
G. SWEET, F.G.S.

Printing Committee:

THE HON. TREASURER.
THE HON. SECRETARY (CONVENER).
PROF. A. J. EWART, D.SC., PH.D.

Honorary Auditors:

J. E. GILBERT.
J. A. SMITH.

Honorary Architect:

W. A. M. BLACKETT.

Trustees:

P. BARACCHI, F.R.A.S.
PROF. W. BALDWIN SPENCER, C.M.G., M.A., F.R.S.
E. J. WHITE, F.R.A.S.

1909.

LIST OF MEMBERS,

WITH THEIR YEAR OF JOINING.

PATRON.

His Excellency Sir Thomas Gibson-Carmichael, Bart. ...	1908

HONORARY MEMBERS.

Forrest, The Hon. Sir J., K.C.M.G., West Australia ...	1888
Liversidge, Professor A., LL.D., F.R.S., Hornton-street, Kensington, Lond.	1892
Neumayer, Prof. George, Ph.D., F.R.S.	1857
Scott, Rev. W., M.A., Kurrajong Heights, N.S.W.	1855
Todd, Sir Charles, K.C.M.G., F.R.S.	1856
Verbeek, Dr. R. D. M., Buitenzorg, Batavia, Java	1886

LIFE MEMBERS.

Butters, J. S., F.R.G.S., Empire Buildings, Collins-street west, Melb.	1860
Eaton, H. F.	1857
Fowler, Thos. W., M.C.E., Colonial Mutual Ch., 421 Collins-street, Melb.	1879
Gibbons, Sydney, F.C.S., 31 Gipps-street, East Melb.	1854
Gilbert, J. E., "Melrose," Glenferrie-road, Kew, Vic. ...	1872
Love, E. F. J., M.A., D.Sc., F.R.A.S., 213 Victoria Terrace, Royal Park, Vic.	1888
Nicholas, William, F.G.S.	1864
Rusden, H. K., Glenhuntly-road, Elsternwick, Vic.	1866
Selby, G. W., 99 Queen-street, Melb.	1881
White, E. J., F.R.A.S., Observatory, Melb.	1868

ORDINARY MEMBERS.

Anderson, J. H., M.B.B.S., Medical School, University, Melb. 1909

Balfour, Lewis, B.A., M.B., B.S., Burwood-road, Hawthorn, Vic. 1892
Baracchi, Pietro, F.R.A.S., Observatory, Melb. 1887
Barnes, Benjamin, Queen's Terrace, South Melb. 1866
Barrett, A. O., "Melisse," Bruce-street, Toorak, Vic. ... 1908
Bavay, A. F. J. de, Foster Brewery, Collingwood, Vic. ... 1905
Boys, R. D., B.A., Public Library, Melbourne 1903
Berry, Prof. R. J. A., M.D., F.R.S.E., University, Melb. 1906

Cherry, T., M.D., M.S., Department of Agriculture, Melb. 1893
Cohen, Joseph B., A.R.I.B.A., Public Works Department, Melb. 1877

Dunn, E. J., F.G.S., "Roseneath," Pakington-street, Kew, Vic. 1893

Ewart, Prof. A. J., D.Sc., F.L.S., University, Melb. ... 1906

Fryett, A. G., care Dr. F. Bird, Spring-street, Melb. ... 1900

Gault, Dr. E. L., M.A., M.B., B.S., Collins-street, Melb. 1899
Gillott, The Hon. Sir S., K.C.M.G.,, "Edensor," Brunswick-street, Fitzroy, Vic. 1905
Gilruth, Prof. J. A., D.V.Sc., M.R.C.V.S., F.R.S.E., University, Melb. 1909
Griffiths, R. F., Commonwealth Meteorological Bureau, Carlton, Vic. 1908
Grut, P. de Jersey, 125 Osborne-street, South Yarra, Vic. 1901

Hake, C. N., F.C.S., Melbourne Club, Melb. 1890
Hall, T. S., M.A., D.Sc. University, Melb. 1890
Hartnell, W. A., "Irrewarra," Burke-road, Camberwell, Vic. 1900
Harvey, J. H., A.R.V.I.A., 128 Powlett-street, East Melb. 1895
Heffernan, E. B., M.D., B.S., ... 1879
Hooper, Dr. J. W. Dunbar, M.D., L.R.C.S., etc., Collins-street, Melb. 1904
Hunt, H. A., Commonwealth Meteorological Bureau, Carlton, Vic. 1908

Jamieson, James, M.D., 96 Exhibition-street, Melb. ... 1877

Kernot, W. N., B.C.E., Working Men's College, Melb. ...	1906
Kershaw, J. A., F.E.S., National Museum, Melb.	1900
Kitson, A. E., F.G.S.	1894
Leach, A. J., M.Sc., Education Department, Melb.	1904
Lyle, Prof. T. R., M.A., University, Melb.	1889
Loughrey, B., M.A., M.D., Ch.B., M.C.E., 1 Elgin-street, Hawthorn, Vic.	1880
Masson, Prof. Orme, M.A., D.Sc., University, Melb.	1887
Michell, J. H., M.A., F.R.S., University, Melb.	1900
Mills, A. L.	1903
Nanson, Prof. E. T., M.A., University, Melb.	1875
Oliver, C. E., M.C.E., Metropolitan Board of Works, Melb.	1878
Robertson, A. W. D., M.B., B.S., University, Melb. ..	1909
Rowe, W. C., "Invicta," Chaucer-street, Canterbury, Vic.	1908
Schlapp, H. H., 31 Queen-street, Melb.	1906
Shephard, John, Clarke-street, South Melb.	1894
Skeats, Prof. E. W., D.Sc., University, Melb.	1905
Spencer, Prof. W. Baldwin, C.M.G., M.A., D.Sc., F.R.S., University, Melb.	1887
Sugden, Rev. E. H., M.A., B.Sc., Queen's College, Carlton, Vic.	1899
Sweet, George, F.G.S., Wilson-street, Brunswick, Vic. ...	1887
Swinburne, The Hon. G., M.L.A., "Shenton," Kinkora-road, Hawthorn, Vic.	1905
Tait, Thos., "Lanark," Queen's-road, South Melb.	1905
Taylor, R., 31 Queen-street, Melb.	1907
Walcott, R. H., F.G.S., Technological Museum, Melb. ...	1897
Ware, S., M.A., Education Department, Melb.	1901
Wisewould, F., 408 Collins-street, Melb.	1902

COUNTRY MEMBERS.

Brittlebank, C. C., Government Vegetable Pathologist's Office, Lonsdale-street, Melb.	1898
Desmond, J., R.V.S., G.M.V.C., "Ellerslie," Hurtle-square, Adelaide, S.A.,	1901

Gregory, Prof. J. W., D.Sc., F.R.S., University, Glasgow 1900

Hart, T. S., M.A., B.C.E., F.G.S., School of Mines, Ballarat, Vic. 1894

Hogg, H. R., M.A., 2 Vicarage Gate, Kensington, W. ... 1890

Ingram, Alex., Hamilton, Vic. 1903

Lea, A. M., F.E.S., Government Entomologist, Hobart 1909

Maplestone, C. M., Eltham, Victoria 1898

Mennell, F. P., Rhodesian Museum, Buluwayo, South Africa 1902

Murray, Stuart, C.E., "Morningside," Kyneton, Vic. ... 1874

Oddie, James, Dana-street, Ballarat, Vic. 1882

Officer. C, G. W., B.Sc., "Kallara," Bourke, N.S.W. ... 1890

Corresponding Members.

Bailey, F. M., F.L.S., Government Botanist, Brisbane, Queensland 1880

Dendy, Professor Arthur, D.Sc., F.L.S., King's College, London 1888

Etheridge, Robert, Junr., Australian Museum, Sydney, N.S.W. 1877

Lucas, A. H. S., M.A., B.Sc., Sydney Grammar School, Sydney, N.S.W. 1895

Stirton, James, M.D., F.L.S., 15 Newton-street, Glasgow 1880

Associates.

Armitage, R. W., Continuation School, East Melb. ... 1907

Bage, Mrs. Edward, "Cranford," Fulton-street, St. Kilda, Vic. 1906

Bage, Miss F., M.Sc., Fulton-street, St. Kilda, Vic. 1906

Baker, Thomas, Bond-street, Abbotsford, Vic. 1889

Bale, W. M., F.R.M.S., Walpole-street, Hyde Park, Kew, Vic. 1887

Bennetts, W. R., Pakington-street, Kew, Vic. 1894

Booth, John, M.C.E., 25 Rathdown-street, Carlton, Vic. 1872
Brook, R. H. T., 119 Errard-street, Ballarat, Vic. 1906

Chapman, F., A.L.S., National Museum, Melb. 1902
Corbett, J., "Clifton," 39 Rushall-crescent, N. Fitzroy, Vic. 1907
Danks, A. T., 391 Bourke-street West, Melb. 1883

Ferguson, W. H., "Maryland Villa," Camberwell-road, Camberwell, Vic. 1894
Finney, W. H., 40 Merton-street, Albert Park, Vic. 1881
Fulton, S. W., 369 Collins-street, Melb. 1900

Gabriel, C. J., Victoria-street, Abbotsford, Vic. 1908
Gabriel, J., Victoria-street, Abbotsford, Vic. 1887
Gatliff, J. H., Commercial Bank of Australasia, Lygon-street, Carlton, Vic. 1898
Grant, Kerr, M.Sc., University, Adelaide, S.A., ... 1905
Green, W. Heber, D.Sc., University, Melb. 1896
Grayson, H. J., University, Melb. 1902

Hardy, A. D., F.L.S., Lands Department, Melb. 1903
Henderson, A. A., M.Sc., Agricultural High School, Wangaratta, Vic. 1905
Herman, Hyman, B.C.E., F.G.S., 60 Queen-stret, Melb. 1897
Hunter, S. B., Department of Mines, Melb. 1908

Jobbins, G. G., Electric Lighting and Traction Co., Geelong, Vic. 1902
Jutson, J. T., "Oakworth," Smith-street, Northcote, Vic. 1902

Kenyon, Mrs. A. F., Highett-street, Richmond, Vic. ... 1908
Kenyon, A. S., Heidelberg, Vic. 1901

Lambert, Thomas, Bank of New South Wales, Benalla, Vic. 1890
Lambie, J., 29 Illawarra-road, Hawthorn 1908
Larking, R. J., "Woorigoleen," Clendon-road, Toorak ... 1905
Luly, W. H., Department of Lands, Treasury, Melb. ... 1896

Mitchell, S. R., Carrington-grove, E. St. Kilda, Vic. ... 1908
Maclean, C. W., "Bronte," Strand, Williamstown, Vic. 1879
Mahoney, D. J., B.Sc., "Coonal," Clendon-road, Toorak, Vic. 1904
Mathew, Rev. John, M.A., B.D., Coburg, Vic. 1890
McEwan, John, 317 Collins-street, Vic. 1898
McKenzie, G. Lands Department, Melb. 1907
Miller, E. E., Boundary-road, Toorak, Vic. 1908

Nicholls, E. B., 164a Victoria-street, North Melb.	1904
Nimmo, W. H. R., B.C.E., 793 Punt-road, S. Yarra, Vic.	1908
O'Neill, W. J., Lands Department, Melb.	1903
Pritchard, G. B., B.Sc. F.G.S., Mantell-street, Moonee Ponds, Vic.	1892
Richards, H. C., M.Sc., Central Technical College, Brisbane, Queensland	1909
Ritchie, E. G., Assoc. M.I.C.E., Met. Board of Works, Melb.	1909
Roberts, R. D., 198 Cotham-road, Kew, Vic.	1909
Sayce, O. A., Harcourt-street, Hawthorn, Vic.	1898
Schafer, R., "Invercloy," Napier-street, Essendon, Vic.	1883
Smith, J. A., 15 Collins-place, Melb.	1905
Summers, H., B.Sc., 49 Airlie-street, S. Yarra, Vic. ...	1902
Sutton, C. S., M.B., B.S., Rathdown-street, N. Carlton, Vic.	1908
Sutherland, Ian M., M.C.E., "Novar," Dandenong, Vic.	1905
Sweet, Miss G., D.Sc., Wilson-street, Brunswick, Vic. ...	1906
Thorn, Wm., Lands Department, Melb.	1907
Thiele, E. O., B.Sc., c/o O. A. Thiele, "Evandale," Chatham-road, Canterbury, Vic.	1898
Traill, J. C., B.A., B.C.E., "Osmington," Domain-road, South Yarra, Vic.	1903
Wedeles, James, 231 Flinders-lane, Melb.	1896
White, Miss R. E. J., M.Sc., Observatory Quarters, S. Yarra, Vic.	1908
Wilkinson, H. L., M.C.E., Equitable Buildings, Melb. ...	1909
Woodward, J. H., Queen's Buildings, Rathdown-street, Carlton, Vic.	1903

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(*The names of new genera and species are printed in italics*).

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